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Precision photometry of early-type galaxies in the Coma and Virgo clusters: a test of the universality of the colour–magnitude relation – I. The data

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SUMMARY

We have undertaken a comprehensive study of a large sample of early-type galaxies in the Virgo and Coma clusters. In the first of two papers, we present accurate *UVJK* photometry for a total of 94 elliptical and S0 galaxies. All *U*- and *V*-band measurements are based on CCD observations made with the 2.5-m Isaac Newton Telescope. *J*- and *K*-band observations for the Coma cluster were made with a chopping photometer at the United Kingdom Infrared Telescope (UKIRT). Virgo *J*- and *K*-band measurements have been taken from Persson, Frogel & Aaronson. The rms internal scatter of these data are respectively: 0.025, 0.015, 0.03 and 0.03 mag for Virgo *U*, *V*, *J* and *K* (60-arcsec aperture) measurements; 0.030, 0.021, 0.026 and 0.027 mag for Coma *U*, *V* (13-arcsec aperture), *J* and *K* (17-arcsec aperture) measurements. We have been careful to ensure that the data set is internally homogeneous. We estimate that the photometric zero-points in the two clusters agree to better than 0.01 mag for *U* and *V*, and 0.02 mag for *J* and *K*.

From these measurements, we have derived $U-V$, $V-K$ and $J-K$ colours corrected for redshift, galactic extinction and aperture effects. After allowing for the systematic uncertainties in these corrections, we estimate that the $U-V$, $V-K$ and $J-K$ colour systems in both clusters are matched to better than 0.02, 0.03 and 0.04 mag respectively. This data set is completed by photometric diameter parameters derived from our own *V*-band data, total *V*-band magnitudes derived from a combination of our measurements and those of Godwin & Peach and Michard, and velocity dispersions and morphological types taken from the literature. A detailed analysis of colour–magnitude correlations of these galaxies will be presented in Paper II (this issue).

1 INTRODUCTION

A comparison of the colours of early-type galaxies in the Virgo and Coma clusters has previously been made (Aaronson, Persson & Frogel 1981, hereafter APF). They combined their own *K*-band photometry (Frogel *et al.* 1978, FPAM; Persson *et al.* 1979, PFA) with optical (*V*-band) and near-ultraviolet (*U*- and *u*-band) photometry published by Sandage (1972, S72) and Sandage & Visvanathan (1978, SV). They found a systematic difference of 0.9 mag in relative distance moduli derived from the $U-V$ and $V-K$ colour–magnitude relations. The offset was in the sense that the early-type galaxies in the Virgo cluster were redder by 0.10 mag in $V-K$ than similar galaxies of the same absolute magnitude in the Coma cluster. They found no evidence for any difference in $U-V$ colour. APF suggested that this effect might be explained if the Virgo galaxies contained a population of intermediate-age asymptotic giant branch (AGB) stars absent from Coma E/S0 galaxies. This hypothesis agrees with spectroscopic evidence, presented in Bower *et al.* (1990) that suggests that early-type galaxies in lower density environments continued to form stars until a more recent epoch than their counterparts in rich clusters. However, several alternative explanations are also possible.

(i) Several corrections must be made to the infrared (IR) photometry data before they can be compared with optical measurements. Each is subject to uncertainty. Firstly, the IR photometer does not measure the flux from the target galaxy through a 'top-hat' aperture. A correction for this effect must therefore be determined by convolving the measured beam profile with the surface-brightness profiles of model galaxies. Secondly, PFA found that an additional correction was required since their observations had been made with a chopping distance between the galaxy and the blank sky channel of only 2–3 galaxy diameters. The sky flux measured by the photometer is then contaminated by light from the outer parts of the galaxy. In addition, we show that the galaxies in the very central parts of the cluster must be corrected for the intracluster light that contaminates the sky channel of the photometer.

(ii) Although APF claimed that their optical photometry was completely homogeneous, there is now evidence to suggest that this is not the case. For example, Michard (1982) finds that the $u-V$ colours of galaxies in the Virgo cluster are systematically redder (by 0.05 mag) than the rest of the SV sample. Hence, the data set used by APF may not have been sufficiently reliable for a comparison at this level.

If correct, APF's result implies that the colour–magnitude relation does not have a universal form. This prevents the colour–magnitude correlation being used to measure extragalactic distances, and may cast doubt on the credibility of any distance indicator based on the photometric properties of early-type galaxies. An independent study of the colours of early-type galaxies in Coma and Virgo is therefore very much required. We have three aims: (i) to significantly enlarge upon the existing sample of galaxies; (ii) to check for systematic differences between the photometric systems in the two clusters, and (iii) to increase the accuracy of the optical photometry.

The strategy of this project is as follows. First, we have obtained independent *K*-band photometry of E/S0 galaxies in the Coma cluster, the mode of operation of the photometer being chosen to minimize the problems incurred by PFA. In addition to enlarging on PFA's sample of galaxies, this photometry is used to test the precision of PFA's photometry and to establish a reliable transformation between the two photometric systems. Secondly, we have obtained new homogeneous optical CCD photometry of early-type galaxies in *both* clusters. By combining these measurements, we obtain accurate instrumental colours, accurately matched in both clusters. Corrections for the differing extinctions and redshifts of the clusters have been estimated without reference to APF. Our colours have been obtained within approximately matching physical (i.e., kpc) aperture sizes. It is not necessary to transform these measurements to colours within an aperture relative to the diameter of the galaxy. (This departs from the procedure adopted by APF.) The colours of the galaxies are now plotted as a function of their total magnitude (V_T), or photometric diameter (D_V). In Paper II, we determine the relative distance modulus from the colour–magnitude (C–M) correlation [and separately from the colour–diameter (C–D) correlation] in each of the colour bands. We compare the values derived with the relative distance estimated from the luminosity–internal velocity dispersion (L–σ) and diameter–velocity dispersion (D_V–σ) relations. We also compare the distance-independent colour–σ and colour–colour (C–C) relations in the two clusters.

Paper I is set out as follows. Section 2 describes the optical observations, their reduction, correction for the effects of atmospheric seeing (using the Fried function) and finally our internal comparison of repeated measurements. Section 3 similarly describes the infrared observations, including a description of the correction applied for the diffuse intracluster light. Section 4 presents a comparison of our photometry with that used by APF. Section 5 describes the corrections that we have applied for galactic extinction, redshift and aperture effects. Our final data set is summarized in Section 6, including a review of the estimated statistical and systematic uncertainties.

2 OPTICAL CCD PHOTOMETRY

2.1 The observations

The observing runs that provided data for use in this project are summarized in Table 1. *U*- and *V*-band observations of the Virgo and Coma clusters were made in three sucessive years at the 2.5-m Isaac Newton Telescope (INT), La Palma. The detector used was the RCA-501EX-thinned CCD, this detector being chosen for its superior blue response over the *uncoated* GEC CCD that was the only available alternative during the 1987 observations. This detector gives a large plate scale of 0.735 arcsec pixel^{-1}. For subsequent runs, the same set-up was used in order to maintain a homogeneous photometric system. We used the set of Schott glass filters provided by the observatory (*U*: 2 mm/UG1 + 5 mm/$CuSO_4$ (solid), *V*: 2/KG3 + 2/BG18 + 2/KG3 + 1/WG280), the same set being used for all observations. These filters closely match those of the standard Johnson system (Johnson & Morgan 1953). However, because of the sharp fall-off in the blue response of the CCD, the *effective U*-band filter, defined by the combined responses of the glass filter and the RCA CCD detector, does not match the standard definition well. Our effective filter peaks at 3750 Å and has a bandwidth of ~350 Å. The spectral response is illustrated in Fig. 1. It can be seen that our filter has a narrower bandpass, and peaks somewhat redward of the standardized filter system proposed by Bessell (1990). It should, however, be noted that the flux from early-type galaxies is also strongly biased to the redward side of the standard band.

Early-type galaxies in Coma and Virgo were selected for observation on the basis of the following criteria. Priority was

Table 1. Summary of observing time.

Dates	Telescope	Observer(s)	Photometric Bands	Useable Nights
7–12 March, 1986	UKIRT	Mountain	J, H, K	3.5
21–25 March, 1987	INT	Lucey	U, B, V	1
18–21 March, 1988	INT	Bower & Ellis	U, V	2
9-12 April, 1989	INT	Bower & Lucey	U, V	3

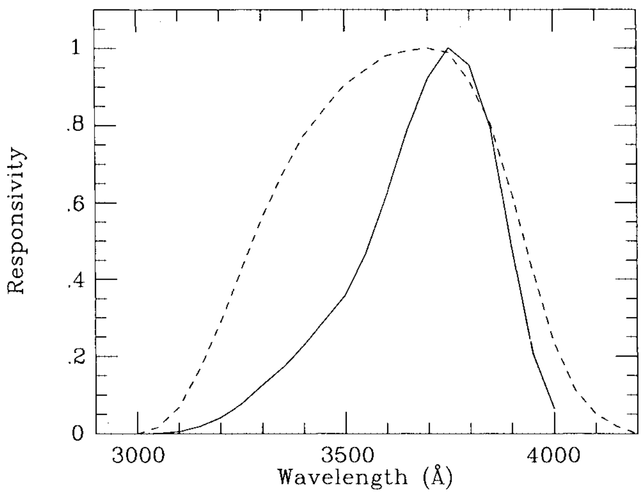

Figure 1. The spectral response of the RGO glass *U*-band filter convolved with the response of the RCA CCD detector and atmospheric transmission (solid line). For comparison, the standardized *U* passband proposed by Bessell (1990) is shown as a dashed line. The responsivity is given in arbitrary units.

given to elliptical galaxies with stellar velocity dispersions and Mg_2 indices published in Dressler (1984). In order that an accurate transformation to the photometric system adopted by APF could be established, we observed a substantial number of galaxies in common with these authors. Additional early-type galaxies were selected at random from Dressler's (1980) list of galaxies with morphological types. Finally, we were concerned to determine the contamination of the sky channel of the infrared photometer by intracluster light during the *K*-band observations of the galaxies in the core of the Coma cluster. For this reason, we obtained a series of overlapping *V*-band images of the cluster centre in order to map the intracluster light.

We observed standard stars selected from Landolt (1983). These were observed throughout the night, in addition to the extensive calibration during twilight. Typically, a total of 20 stars were observed on each night. Care was taken to ensure the colours of the stars matched the range of galaxian colours, and that observations of stars at one particular airmass were not biased to one extreme of colour. In addition to our observations of standard stars, we frequently made repeated measurements of selected 'standard' galaxies in the Virgo and Coma clusters. These observations were interleaved with measurements of previously unobserved galaxies so as to monitor the consistency of photometric conditions. This precaution is especially important in the *U*-band as the standard stars used to transform the raw CCD magnitudes to the Johnson system have different spectral energy distributions to the galaxies.

The measured extinctions and colour terms were typically 0.14 and $0.05(B-V)$ in the *V*-band, and 0.45 and $-0.04(U-B)$ (for stars redder than $U-B=0.3$ mag) in the *U*-band. In the *U*-band, it was not possible to fit a simple colour term to stars bluer than 0.3 mag. This effect is not surprising given the non-standard nature of our effective *U*-band. As a result, however, there may be a small residual offset between our CCD *U*-band *galaxy* photometry and that measured through the standard filter. Over the colour range covered by the galaxies that we observed, the colour term may be regarded as constant in both bands. Finally, we tested for a colour dependence of the extinction, but none was detected in either band (i.e. the effect is less than 0.01 mag). With the coefficients in the above equation defined from our standard star observations, the magnitudes of our standard galaxies have an rms scatter of 0.007 mag ($n=45$) in the *V*-band, and 0.012 mag in the *U*-band. In addition to the calibration described above, we frequently cycled between the two clusters and the two colour bands to ensure the homogeneity of the measurements obtained.

For the majority of galaxy exposures, the sky flux was determined from manually selected regions devoid of contaminating stars. The dispersion in these sky measurements was used to estimate the corresponding uncertainty in the galaxy magnitude. This approach is possible by virtue of the large area covered by the CCD. Nevertheless, for larger galaxies in the Virgo cluster, it is difficult to be certain that a true background sky flux can be measured. Fortunately, these galaxies are sufficiently bright that the uncertainty in the adopted sky flux has negligible effect on their magnitudes out to 90 arcsec. For the galaxies embedded in the haloes of the central D galaxies in the Coma cluster [NGC 4874 (D148) and NGC 4889 (D129)] we determined the local background (i.e., sky plus intracluster light) flux by interpolating across the galaxy.

Tables 2–5 (on microfiche MN254/2) present the individual measurements of the *U*- and *V*-band magnitudes of galaxies in the Virgo and Coma clusters. We present a range of standard apertures spaced so that magnitudes at any other aperture can be accurately determined by interpolation. It should, however, be remembered that the errors in successive apertures are strongly correlated. The inner limit to the apertures is set by the requirement that the seeing correction be reasonably small. The outer aperture is limited in Coma by statistical fluctuations in the sky flux, and in the brighter Virgo galaxies by the difficulty in establishing the true background sky level (i.e., without contamination from the galaxian halo). Additionally, we present measurements at 17 arcsec in Coma, and 60 arcsec in Virgo as these are of special interest for this project. The magnitudes quoted refer to measurements made after contaminating stars had been patched out, but have not been corrected for atmospheric seeing (correction for this effect is discussed in the following section). We indicate with a colon magnitudes for which the statistical fluctuations in the sky background determination introduce an uncertainty of between 0.03 and 0.04 mag. (These measurements have been used to derive accurate colours by averaging the repeat observations.)

2.2 Correcting for atmospheric seeing

During our optical observations, the atmospheric seeing varied between 1.5 and 3 arcsec. During poor seeing, observations were confined to the Virgo cluster. Corrections for atmospheric seeing were determined by convolving model $r^{1/4}$-law galaxies with a model seeing point spread function (PSF). On theoretical grounds, we adopted the Hankel transform of the combined modulation transfer function of the telescope and atmosphere (see Roddier 1981). Unlike the often-adopted Gaussian function, this representation provides an adequate representation of the outer wings of the observed PSF. The FWHM of the seeing PSF was measured from stars in the same frame or, if this was not possible, by interpolation between adjacent frames. The correction is only very weakly dependent on the size of the model galaxy. In the Coma cluster we adopted $r_e = 5$ arcsec for all galaxies, in the Virgo cluster $r_e = 30$ arcsec. The corrections have been tabulated in Table 6 (on microfiche MN254/2). For most measurements, the correction was less than 0.02 mag. We caution any measurements which have been corrected by more than 0.20 mag. Otherwise, the size of the correction is so small that its uncertainty is negligible in comparison with the other sources of random error.

2.3 Internal comparison

In order to determine the random uncertainty in our photometric data, we have made an internal comparison of our repeated measurements. The results for each photometric band are summarized in Table 7. The four comparisons are illustrated as a function of magnitude in Figs 2(a)–(d). The apertures tabulated will be used to derive galaxian colours. The comparison includes corrections for atmospheric seeing. Individual measurements marked as uncertain in Tables 2–5 have not been used. Typically, the rms difference between measurements is 0.02 mag. This is the limit of photometric stability in our data. However, the Coma U-band photometry has a larger rms scatter of 0.03 mag. The photometric accuracy in this band is limited by the statistical uncertainty in the sky background subtraction.

It is also important that we determine the level at which systematic errors may enter our data. Because the observations of the Virgo and Coma clusters have been interleaved, the photometric zero-points of the two clusters are unlikely to be offset by more than 0.01 mag.

3 INFRARED PHOTOMETRY

3.1 The observations

The J- and K-band photometry of early-type galaxies in the Coma cluster was obtained during five dark nights (1986 March 7–12) at the United Kingdom Infrared Telescope (UKIRT) on Mauna Kea, Hawaii. The observations were made through a relatively large aperture of 19.6 arcsec

Table 7. Summary of internal comparisons.

Cluster	Photometric Band	Aperture Dia.	Number of Comparisons	RMS Difference
Virgo	V	60″	16	0.015
	U	60″	10	0.025
Coma	V	13″	135	0.021
		17″	135	0.020
	U	13″	29	0.030
	J	17″	29	0.026
	K	17″	28	0.027

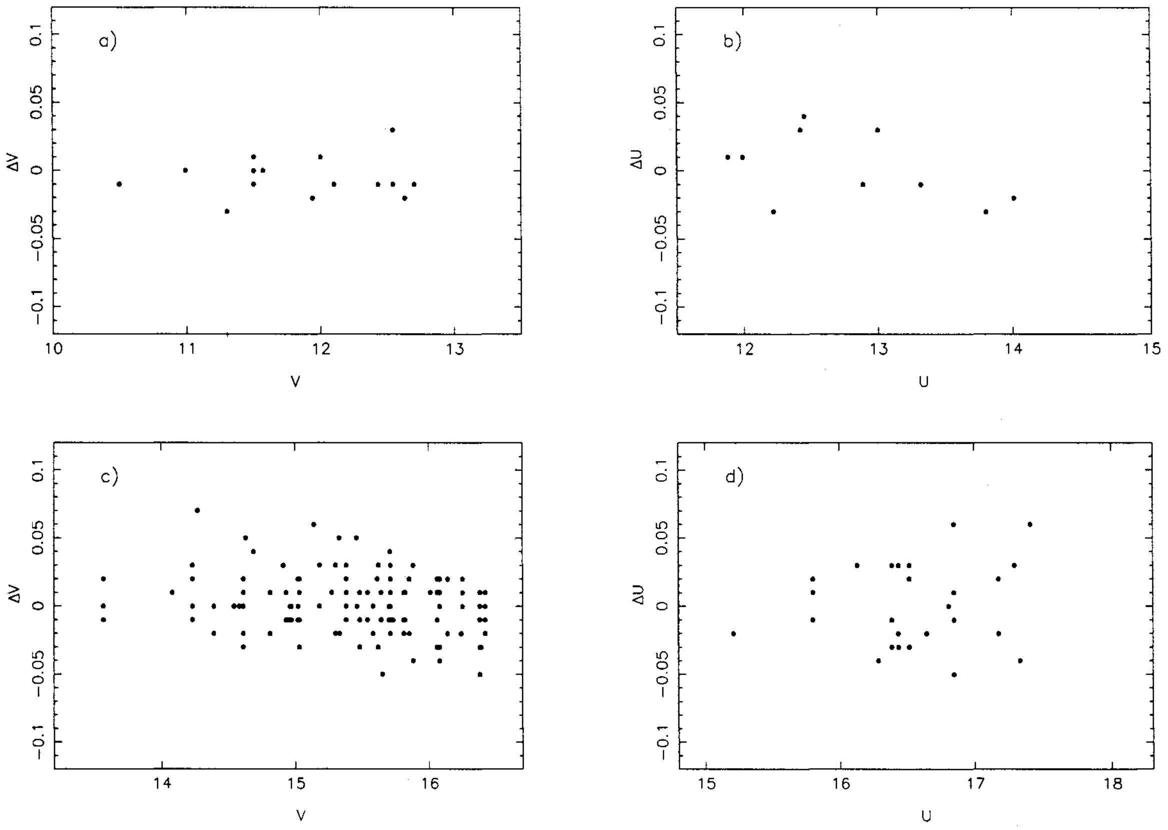

Figure 2. Internal comparison of U- and V-band CCD photometry. (a) Virgo V-band at 60-arcsec aperture. (b) Virgo U-band at 60-arcsec aperture. (c) Coma V-band at 13-arcsec aperture. (d) Coma U-band at 13-arcsec aperture.

nominal diameter. As a result, the measurements are insensitive to atmospheric seeing (typically 1–2 arcsec) and to the accuracy with which the galaxy was centred. The chopping throw of the telescope was set to the large value of 150 arcsec in order that there would be no contamination of the sky channel of the photometer by flux from the outer parts of the galaxy (*cf.* Frogel *et al.* 1978, FPAM).

Zero-point calibration of galaxy exposures was achieved using local reference stars in the field of the Coma cluster. These stars were in turn calibrated onto the CIT photometric system (described by FPAM) by observing standard stars selected from Elias *et al.* (1982).

Galaxy observations were centred by offsetting from one of several astrometric reference stars, accurate positions having been derived from the data of Godwin, Metcalfe & Peach (1983). This position was checked by maximizing the signal received by the photometer. On alternate nights, the telescope was chopped in east–west (E–W) and north–south (N–S) orientations. The appropriate direction for each galaxy was chosen so that the two positions of the sky channel of the photometer were not contaminated by brighter stars or another galaxy. A number of galaxies were observed with both chop orientations in order to check for consistency.

In order to relate photometry performed with the UKIRT beam to measurements made through a top-hat aperture, the beam profiles measured each night were convolved with (*V*-band) aperture photometry of Coma galaxies of varying magnitudes. A mean correction, that converted the instrumental measurement into a magnitude measured through a 17-arcsec top-hat aperture, could then be defined for each galaxy. This correction is typically 0.02 mag with an uncertainty (arising from the different surface brightness profiles of the galaxies) of much less than 0.01 mag. Uncertainties introduced by the gradient in the V–K (or V–J) colour are entirely negligible. The top-hat aperture size of 17-arcsec diameter was selected to match the FWHM (full width at half maximum) of the beam profile.

Because of the high galactic latitude of the Coma cluster, and the relatively small size of the photometer aperture, few of the magnitudes measured were affected by contaminating galactic stars. The two galaxies for which contamination is a significant problem (D121 and D159) have been deleted from our sample as accurate subtraction of the secondary component was not possible.

Our *J*- and *K*-band photometry of Coma cluster elliptical and S0 galaxies is given in Table 8 (on microfiche MN254/2). The magnitudes quoted have been corrected for the beam profile of the telescope, but not for the diffuse intracluster light that, in a few cases, contaminates the sky channel of the photometer (this is discussed and a correction applied in Section 3.2). The internal scatter in our repeated measurements (no distinction has been drawn between observations with N–S and E–W chopping directions) is 0.026 mag (*J* band, $n=29$) and 0.027 mag (*K* band, $n=28$). Note that two of the galaxies in this comparison will be found to require different 'chopping corrections' (to allow for intracluster light) in the repeated observations. The differences in these corrections are, however, so small that the internal scatter of the whole sample is not significantly altered when they are applied. A graphical representation of the comparison is presented in Figs 3(a) and (b).

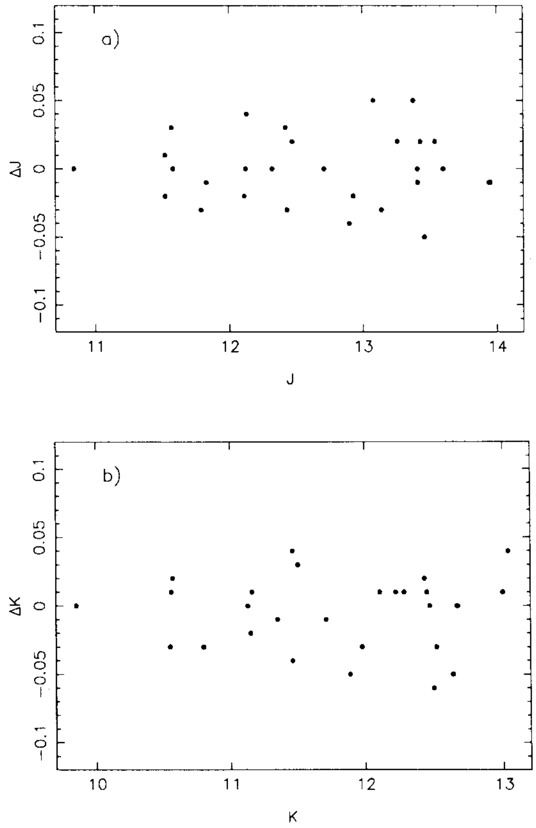

Figure 3. Internal comparison of UKIRT *J*- and *K*-band photometry in the Coma cluster: (a) *J*-band, (b) *K*-band. The measurements compared have been corrected for beam profile effects, but not for the effects of intracluster light.

3.2 Correcting for intracluster light

The two dominant galaxies in the Coma cluster [NGC 4874 (D148) and NGC 4889 (D129)] have large extended haloes. In the previous tables (on microfiche), we have presented optical and infrared photometry for several galaxies that are embedded in this intracluster light. However, before we can compare these magnitudes, we must ensure that the contribution from the background light has been dealt with consistently. In our optical data, we were able to determine the local background (i.e., sky plus intracluster light) flux by interpolating across the galaxy. This procedure is not possible in the infrared. However, because of the large chopping offset (150 arcsec) of the sky channels of the infrared photometer, the infrared magnitudes are, in general, equivalent to optical magnitudes corrected for the sky flux only. We must therefore apply a correction based on our optical data so that the magnitudes can be placed on a consistent system. Furthermore, for a few galaxies, one of the sky channels of the infrared photometer lies in a region where the background is enhanced by the halo light. In these cases, we have used our *V*-band CCD images to reproduce an equivalent *V*-band measurement.

The values derived for these corrections are presented in Table 9 (on microfiche MN254/2). We estimate that the uncertainty in a correction of 0.10 mag arising from V–K (and V–J) colour differences and from uncertainty in the background flux is less than 0.02 mag. In the Table, we have indicated the corrections for which the uncertainties may be larger than 0.03 mag.

4 COMPARISON WITH PREVIOUS WORK

The main purpose of this section is to compare our photometry with that presented by PFA. We have two aims. First, by assessing the reliability of PFA's Coma *J*- and *K*-band photometry, we can determine whether it is possible to adopt the *J*- and *K*-band measurements that they present for Virgo galaxies. Secondly, by comparing the optical magnitudes derived by these authors from Sandage (1972) and Sandage & Visvanathan (1977, 1978) with our homogeneous *V*-band photometry, we will make a first step towards eliminating possible systematic effects that could give rise to a spurious colour difference between galaxies in the two clusters. We also compare our RCA CCD *U*-band measurements and the SV *u*-band measurements adopted by PFA. Because the responses of these filters are markedly different, a large zero-point offset is expected in this comparison. We present a summary of the results of this section in Table 10.

PFA present *J*- and *K*-band magnitudes for galaxies in the Coma cluster with an aperture diameter of 14.9 arcsec (corrected for beam profile effects). In order to perform a comparison with our data (17-arcsec aperture), we determine an aperture transformation from our *V*-band CCD data. Under the assumption that colour gradients are small, the difference in the *J* (or *K*) magnitudes at the two apertures is the same as that determined in *V* (before any correction is made for intracluster light). The colour gradients measured by PFA and Peletier, Valentijn & Jameson (1990) suggest that the error in this procedure is much less than 0.01 mag. The comparison is shown in Figs 4(a) and (b). We reject the three faint galaxies D170, 127 and 128 from the comparison as these galaxies stand out from the mean relation. We suggest that the discrepancy is unlikely to be due to random error. Comparing 13 galaxies, we find a mean *J*-band offset of 0.014 ± 0.013 mag (with rms scatter of 0.048), and a mean *K*-band offset ($K_{\rm PFA} - K_{\rm UKIRT}$) of 0.007 ± 0.009 mag (with rms scatter of 0.032). The scatter in the *K*-band measurements is as expected if both data sets have errors ~ 0.025 mag. The larger scatter between the *J*-band magnitudes probably reflects the larger uncertainty quoted by PFA. In both bands there is no significant offset.

In addition, Peletier *et al.* (1990) have performed an independent check on the calibration of PFA's Virgo galaxies. Their photometry uses the infrared camera on UKIRT. The zero-points they derive from Elias *et al.* (1982) standard stars and from the aperture measurements of PFA agree to 0.006 ± 0.009 (*J*-band, $n = 7$) and 0.001 ± 0.012 (*K*-band, $n = 7$). Again there is no significant offset.

We did not make *J*- and *K*-band measurements of galaxies in the Virgo cluster. However, the results presented above give us confidence in the reproducibility of the zero-point of PFA's photometry, and we therefore directly adopt PFA's *J*- and *K*-band photometry of galaxies in the Virgo cluster. The

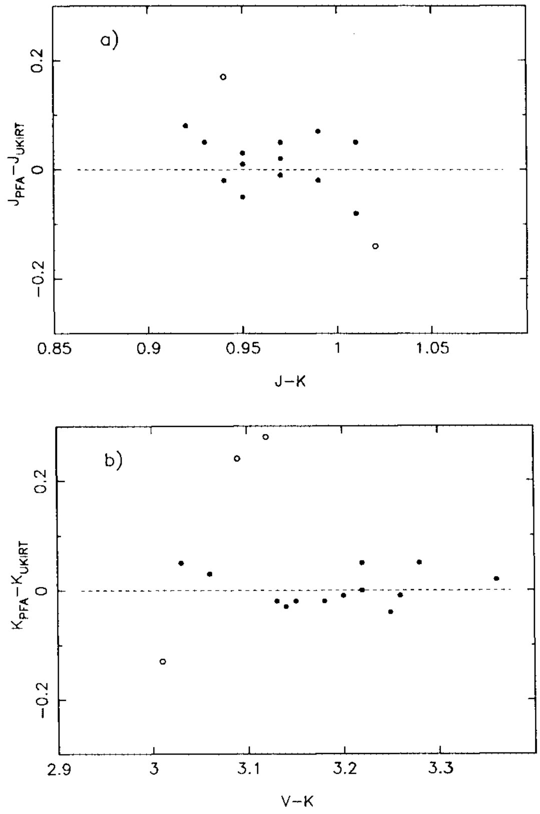

Figure 4. Comparison of UKIRT *J*- and *K*-band magnitudes with the work of Persson *et al.* (1979, PFA): (a) *J*-band, (b) *K*-band. The faint galaxies (D127, 128 and 170) have been plotted as open symbols. These were excluded from the comparison as their errors are not consistent with the other data. Dashed lines show the expected mean relation if both sources of data share a consistent photometric system.

Table 10. Summary of comparison with photometry used by APF.

Cluster	Filter	Number of Points	RMS Scatter	Zero-point Offset	Comments
Virgo	V	20	.035	.011 ± .008	N4478, N4636 excluded
	U	20	.088	.839 ± .019	
Coma	V	18	.025	−.025 ± .006	
	U	12	.044	.797 ± .012	
	J	13	.048	.013 ± .013	D127, D170 excluded
	K	13	.032	.005 ± .009	D127, D128, D170 excluded

Offsets are calculated as (other) − (this paper).

systematic error between the zero-points of the measurements of the Coma cluster (this work) and those of the Virgo cluster (taken from PFA) is unlikely to be greater than 0.02 mag.

A more recent study of the infrared properties of galaxies in the Virgo and Coma clusters has been published by Recillias-Cruz *et al.* (1990, 1991). Although their Coma cluster sample is larger than the one presented here, their data have considerably larger random errors. Comparison with our work shows a scatter of 0.07 mag (J-band) and 0.07 mag (K-band), in agreement with the authors' estimates. In addition, the aperture of their Virgo galaxy photometry is too small (14.9 arcsec) to be of use in this project. We do not, therefore, consider this data further.

To complete our comparison with previous work, we compare our U and V measurements with those derived by APF from SV and S72. The comparison is illustrated in Figs 5(a) and (b). We first consider the V-band data. In the Virgo cluster, we find (rejecting the two discrepant galaxies NGC 4478 and 4636) a scatter of 0.035, with offset ($V_{S72}-V_{CCD}$) 0.011 ± 0.008 ($n=20$). For Coma, we find a scatter of 0.025 with offset -0.020 ± 0.006 ($n=18$). While

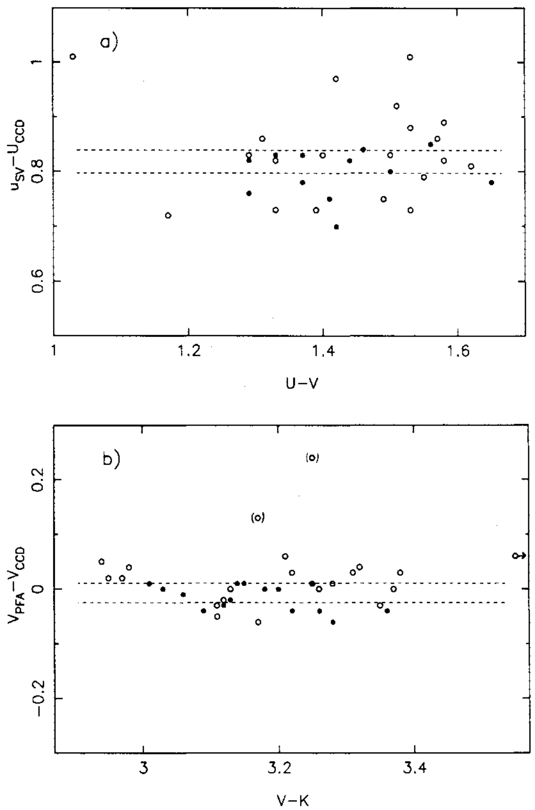

Figure 5. Comparison of CCD U- and V-band photometry with the data derived by Aaronson *et al.* (1981, APF) from the work of Sandage (1972, S72) and Sandage & Visvanathan (1978, SV): (a) U-band, (b) V-band. Virgo galaxies are plotted as *open* symbols, Coma galaxies as *solid* points. Dashed lines show the mean offsets found separately for each cluster. The V-band offset shown excludes the discrepant galaxies NGC 4478 and 4636 (bracketed points). The large zero-point offset in the U-band comparison results from the difference in the spectral responses of our CCD U-band and SV's u-band filters.

the scatter between the measurements is encouragingly small, it is clear that there is a significant offset (Virgo – Coma) of 0.031 ± 0.010 between the zero-points of the photometry in the two clusters. We note that the offset is in such a sense as to make PFA's $V-K$ colours of galaxies in the Virgo cluster appear redder than equivalent galaxies in Coma.

The U-band comparison shows a larger scatter. In Virgo, we find a scatter of 0.088 with offset ($u_{SV}-U_{CCD}$) 0.839 ± 0.019 ($n=20$). (The large magnitude of this offset results from the difference in the filter bandpasses). In Coma, we find a scatter of 0.044 with offset 0.797 ± 0.013 ($n=12$). There is a small difference (of 0.042 ± 0.023) in the mean offsets of the Virgo and Coma data. As this is similar to the mean offset found for the V-band data, the net offset in $U-V$ colour is only 0.011 mag. The unexpectedly large scatter of the Virgo comparison is dominated by three galaxies (NGC 4476, 4435 and 4636). If these galaxies are omitted from the comparison, the scatter is reduced to 0.062 mag. The mean offset is also reduced. These galaxies also have large V-band residuals. The scatter in the $U-V$ colours will therefore be smaller than the scatter found in the individual photometric bands.

It is also useful to compare our U and V measurements for Virgo with the derived values quoted by Michard (1982) at 60-arcsec aperture. In the V-band, we find a scatter of 0.036, with offset [$V_{Mic}-V_{CCD}$] 0.019 ± 0.008 ($n=20$). In the U-band, we find a scatter of 0.040 with offset (due to the difference in bandpass) [$U_{Mic}-U_{CCD}$] 0.048 ± 0.011 ($n=12$). Dividing the scatter equally between the data sets suggests that our V-band errors are 0.025 mag, (this is slightly larger than our internal comparison suggests), and U-band errors are 0.028 mag (in good agreement with our internal estimate). In Paper II, we will assess the case for an intrinsic scatter in the properties of the galaxies. This independent confirmation of our error estimates makes this analysis more concrete. The small V-band offset suggested by this comparison is not of importance as we will not introduce any external V-band measurements into our study.

The comparisons we have made above allow us to make some preliminary comments on APF's comparison of the colour–magnitude relations in Virgo and Coma. These authors found that the Virgo–Coma colour–magnitude distance modulus was systematically 0.9 mag smaller when measured in $V-K$ colour compared with the offset in $U-V$ colour. Equivalently, they concluded that, at fixed $U-V$ colour, early-type galaxies in Virgo were 0.10 mag redder in $V-K$ than equivalent galaxies in Coma. The offsets reported here between APF's photometry and our new work explain some of this discrepancy. For example, the offset in the Virgo and Coma V-band magnitudes suggests that, at fixed luminosity, the $V-K$ colour discrepancy should be reduced by 0.03 mag. Comparison of the $U-V$ colours is more complicated because of the differing filter bandpasses. We discuss this issue fully in Paper II.

5 GALAXY COLOURS CORRECTED FOR REDSHIFT, REDDENING AND APERTURE SIZE

5.1 *K*-corrections

The Virgo and Coma clusters have mean redshifts of 0.003 and 0.023 respectively. We must therefore apply K-

corrections to our data to allow for the differing effective bandpasses and central wavelengths of the filters in the rest-frames of the two clusters. As these corrections amount (in some bands) to a substantial fraction of the intrinsic colour differences found by PFA, we have re-examined the values adopted by these authors. In addition, the blue cut-off of the spectral response of the RCA CCD makes our effective U-band substantially narrower than the standard Johnson definition of the band. The K-correction in this band is therefore likely to differ from the term conventionally adopted. Finally, the revised study of the K-corrections allows us to estimate their uncertainty by varying the spectral response of the filter and the spectral energy distribution (SED) of the template galaxy.

Numerical values for each of the K-corrections were determined by convolving a variety of galaxy SEDs (at an appropriate redshift) with the combined spectral response of the relevant filter and detector. A wide choice of template early-type galaxy SEDs was available to define the U-and V-band K-corrections (*cf.* Bruzual 1984). These ranged from a composite SED made by combining observations of several elliptical galaxies (Ellis, private communication) to the UV-strong elliptical NGC 4649 (Bertola, Capacciolli & Oke 1982) and the bulge of M31 (Coleman, Wu & Weedman 1980). Response curves for the filters and the RCA CCD were obtained from the RGO CCD User's Guide (Wall *et al.* 1989).

The K-corrections we derived for the standard U and V filter response curves are in good agreement with those quoted by PFA. Using the combined response curves of our filter, CCD and atmosphere, we found (for the mean elliptical SED): at Virgo ($z=0.003$) $K(V)=0.005$, $K(U-V)=0.002$; at Coma ($z=0.023$) $K(V)=0.041$, $K(U-V)=0.003$. The K-correction we derive in the RCA CCD U-band is much smaller than the standard value [$K(U-V)=0.026$ at $z=0.023$]. Fig. 6 shows the elliptical galaxy SED and the effective response curves of each photometric band. Our effective U filter is peaked at the redward end of a plateau in the ultraviolet fall-off of the SED. The effect of redshifting the spectrum should therefore be similar in both the U- and V-bands – as we have found. Initially, we were concerned that this correction would be strongly dependent on galaxy colour, but experiment with the other energy distributions available to us, and with synthetic SEDs made by co-adding spectra of young and old star clusters in variable ratios, showed that this is not the case – for all SEDs with colours resembling those of elliptical galaxies we find $|K(U-V)|<0.01$. We also experimented with the effects of varying atmospheric absorption on the effective filter response curve, but found that this does not significantly alter the values found. We therefore adopt $K(V)=1.8z$ and $K(U-V)=0.00$, the uncertainty being less than 0.01 mag (for $z<0.03$) in both cases.

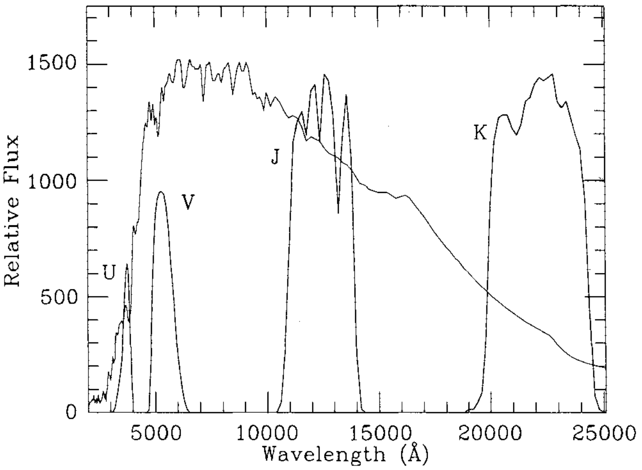

Figure 6. The approximate spectral energy distribution (SED) of a typical early-type galaxy from the near-ultraviolet to the near-infrared. The curve has been formed by appending the infrared SED of the K-giant star α Tau to the mean observed optical SED of several nearby elliptical galaxies. The heavier lines show the effective spectral response curves of the U, V, J and K filters used in this project.

In the infrared, there is only one suitable spectral energy distribution available for the calculation of K-corrections for early-type galaxies – that of the K3 giant star α Tau, obtained in a balloon-borne observation by Woolf, Schwarzschild & Rose (1964). As population synthesis models suggest that such stars dominate the infrared light of old stellar populations, we expect that the K-corrections determined from this SED will closely approximate the true value. Using the UKIRT filter response curves (supplied by the Royal Observatory Edinburgh) we find (for $z<0.03$); $K(K)=-3.5z$, $K(J)=+0.15z$. These figures are not significantly altered if the response curves of the standard Johnson filters are used instead. PFA adopted $K(K)=-3.5z$, $K(J)=+0.7z$. The origin of the small discrepancy in the J-band correction is unknown. The accuracy of these K-corrections is clearly limited by the fact that they are derived from a single star and not from a composite stellar population. However, Frogel *et al.* (1978) have shown that the extreme stars μ Gem (M3III) and α Ori (M2I) (also observed by Woolf *et al.*) give K-corrections differing by less than 0.02 mag (at $z=0.03$) from those derived from α Tau. We will therefore adopt an uncertainty of 0.02 mag for the infrared K-corrections that we apply to galaxies in the Coma cluster.

5.2 Galactic extinction

Because both the Coma and Virgo clusters have high galactic latitude ($b>60°$), they can be expected to have similar low reddening. In the absorption-free polar cap model of Sandage (1973), the reddening is exactly zero. PFA therefore applied no extinction corrections to their published colours. Reddening estimates based on galaxy counts and H I gas column densities (Burstein & Heiles 1984, BH) suggest that, while the mean absorption is similar for the two clusters, there is a scatter in the galactic extinctions to individual Virgo galaxies because of the large angular size of the cluster. We have examined the colour–magnitude and colour–diameter correlations presented in the subsequent sections for a residual correlation between the deviation of a galaxy from the mean colour relation and its reddening as estimated by Burstein & Heiles. No correlation is detectable in either the $U-V$ or $V-K$ colours. We therefore chose not to apply reddening corrections on a galaxy-by-galaxy basis, and apply the same extinction correction to all galaxies in both clusters. We emphasize that this is in agreement with the *mean* extinction estimates of BH. The relative extinction in our CCD U-band was estimated from Whitford (1958). We adopted $E(U-V)=0.36A_B$.

5.3 Aperture size

Because of the greater distance of Coma, galaxies in the two clusters have different apparent (i.e., angular) sizes. Since the colours of galaxies are known to vary with radius (e.g., Peletier *et al.* 1991 and references therein), we must be careful to compare the colours of galaxies at the same physical radius in both clusters. This is conventionally achieved by using a mean colour gradient to transform the aperture colour that is measured to a colour within a fixed fraction of the galaxy's optical diameter. Since the strengths of colour gradients in individual galaxies are highly variable, we do not attempt to make this transformation. Instead, we compare the colours at a fixed metric (i.e., kpc) aperture. While this method is equally as valid as the conventional one, it should be noted that the slopes of the colour–magnitude relations presented here will differ from those based on relative aperture sizes.

Although our approach allows us to compare intrinsic properties close to those we have measured, there remains a small mismatch between the *physical* sizes of apertures used in the two clusters (these apertures having been chosen to facilitate the accuracy of our work). A 60-arcsec aperture in the Virgo cluster should be matched by an aperture of 11 arcsec in Coma (assuming a Local Group infall velocity to Virgo of 250 km s^{-1}). These angular apertures correspond to a physical diameter of 5 h^{-1} kpc at the distance of each of the target clusters. To transform our measured Coma galaxy colours to the 11-arcsec aperture, we apply a small correction based on the mean colour gradient. Colour gradients have been taken from Peletier *et al.* (1990) ($U-V$ and $V-K$) and FPAM ($J-K$). They translate into corrections of 0.01 mag in $U-V$ (measured at 13 arcsec) and 0.03 and 0.02 mag in $J-K$ and $V-K$ (measured at 17 arcsec). Errors arising from the uncertainty in the Virgo–Coma relative distance affect the colours by far less than 0.01 mag. There is, however, considerable variation in the gradients measured for individual galaxies; we therefore infer an uncertainty of 0.01 mag in the $U-V$ and $V-K$ corrections adopted, the correction in $J-K$ being much less reliably determined.

6 TABLES OF $U-V$, $V-K$ AND $J-K$ COLOURS

In Tables 11 and 12, we present homogeneous $U-V$ and $V-K$ colours for galaxies in the Virgo and Coma clusters. The colours have been corrected for redshift using the K-corrections discussed in Section 5.1. In the Virgo cluster, the very small correction has been varied depending on the redshift of the individual galaxy (taken from Binggeli, Sandage & Tammann 1985). As discussed in Section 5.2, the same correction for galactic extinction [corresponding to $A_B=0.05$ (BH)] has been made in both clusters. In addition, a correction has been made to normalize the measurements to a constant physical (i.e., kpc) aperture size. These corrections are summarized in Table 13.

We estimate the total uncertainty of the matching of the absolute colour systems in the two clusters as follows. In the U- and V-bands, the photometric zero-points agree to better

Table 11. Photometry of galaxies in Virgo.

I.D.	Type	V_T	D_V	$\log\sigma$	U-V	V-K	J-K
N4124	$S0_3(6)$:	11.21	1.380	–	1.04	2.94	0.79
N4339	$S0_{1/2}(0)$	11.40	1.526	–	1.35	–	–
N4365	E3	9.62	1.882	2.412	1.52	3.28	0.91
N4371	$SB0_2(r)(3)$	10.79	1.699	2.104	1.49	3.18	0.87
N4374	E1	9.22	2.008	2.480	1.55	3.28	0.90
N4377	$S0_1(3)$	–	1.577	2.134	1.31	3.09	0.80
N4382	$S0_1(3)$pec	9.09	–	2.301	1.36	3.07	0.83
N4387	E5	11.99	1.465	2.059	1.37	3.08	0.78
N4406	$S0_1(3)$/E5	9.09	1.944	2.355	1.53	3.25	0.86
N4435	$SB0_1(6)$	10.66	1.759	2.233	1.39	3.55	0.98
N4442	$SB0_1(6)$	10.30	1.836	2.336	1.47	3.24	0.87
N4458	E1	11.90	1.391	1.949	1.30	2.93	0.71
N4464	E3	–	1.433	2.079	1.29	–	–
N4468	S0/a	12.90	1.078	–	1.12:	2.94	–
N4472	$E2/S0_1(2)$	8.32	2.137:	2.474	1.60	3.32	0.89
N4473	E5	10.06	1.857	2.268	1.48	3.18	0.83
N4476	$S0_3(5)$	12.28	1.409	–	1.01	2.90	0.79
N4478	E2	11.23	1.670	2.170	–	3.13	0.81
N4486	E0	8.62	2.089	2.528	1.56	3.34	0.93
N4550	$E7/S0_1(7)$	11.50	1.586	–	1.27	3.09	0.85
N4551	E2	11.86	1.487	2.021	1.45	–	–
N4552	$S0_1(0)$	9.86	1.903	2.391	1.56	3.33	0.92
N4621	E4	9.81	1.902	2.338	1.52	3.22	0.92
N4636	$E1/S0_1(1)$	–	1.873	2.303	1.50	3.21	0.91
N4660	$E3/S0_1(3)$	11.11	1.711	2.262	1.37	3.14	0.84
N4697	E6:	–	1.982	2.276	1.40	–	–

The values quoted have been corrected for redshift and reddening. The colours refer to an aperture size of 60 arcsec.

Table 12. Photometry of galaxies in Coma.

I.D.	Type	V_T	D_V	$\log\sigma$	U-V	V-K	J-K
D10	E	16.01	0.475	–	–	–	0.83
D31	E/S0	12.44*	1.278	2.449	–	3.26	0.90
D49	E	12.96*	1.269	2.394	–	3.27	0.92
D67	S0	15.13	0.851	2.169	–	3.12	0.86
D68	S0	14.57	0.900	2.111	1.41	–	–
D69	E	14.07	1.064	2.285	1.51	3.24	0.89
D70	E	14.70*	0.948	2.166	1.41	3.08	0.87
D71	S0	16.76*	0.569	–	1.18	–	–
D78	E	13.61	1.144	–	–	3.14	0.88
D79	S0	13.75	1.128	–	–	3.20	0.89
D81	E	14.99	0.829	–	–	2.94	0.83
D84	S0	14.85	0.870	–	–	3.14	0.89
D87	E	15.72	0.726	1.863	–	2.91	0.85
D91	S0	14.06	1.105	–	–	3.15	0.88
D95	S0	–	1.065	–	–	3.12	0.91
D96	E	14.38	0.964	–	–	3.20	0.92
D103	S0/a	14.23	1.081	2.319	1.49	–	–
D104	S0	14.69*	0.982	2.260	1.46	–	–
D106	S0	15.38*	0.852	2.201	1.36	–	–
D107	E	15.29	0.753	1.761	1.24	2.91	0.85
D110	S0/E	15.25	0.962	–	–	2.36*	0.86*
D116	SB0	14.90*	0.836	2.114	1.23	–	–
D118	E	14.20*	1.029	2.209	1.45	3.14	0.87
D119	S0	15.12	0.843	2.186	1.35	–	–
D122	S0	14.97	0.877	1.957	1.22	–	–
D124	E	14.37	1.030	2.243	1.47	3.13	0.88
D125	E	15.44	0.874	2.169	1.36	3.01	0.85
D126	S0	15.72	0.705	–	1.23	–	–
D127	S0	15.78*	0.651	–	1.37	3.10	0.87
D128	S0	15.45*	0.759	2.019	1.27	3.07	0.88
D129	D	12.11*	1.287	2.383	1.56	3.25	0.94
D130	E/S0	14.20*	1.048	2.311	1.45	3.17	0.92

Table 12 – *continued*

I.D.	Type	V_T	D_V	$\log\sigma$	U-V	V-K	J-K
D131	S0	14.09*	1.014	2.225	1.49	–	–
D132	S0	15.71*	0.733	2.104	1.33	–	–
D133	E	14.34*	1.060	2.339	1.43	3.18	0.90
D134	E	15.93*	0.695	–	1.31	–	–
D135	E	15.81	0.677	–	1.29	–	–
D136	E	15.36*	0.877	2.251	1.36	3.07	0.87
D143	E	13.30	1.107	2.361	1.55	3.22	0.89
D144	S0/a	14.12*	1.050	2.210	1.42	3.24	0.90
D145	S0	14.66	0.872	2.124	1.40	–	–
D147	S0	14.98	0.746	–	1.32	–	–
D148	D	11.69*	1.481	2.584	1.63	3.35	0.92
D150	E	15.15	0.868	2.007	1.35	3.04	0.86
D151	E	13.82	1.036	2.180	1.33	3.03	0.85
D152	SB0	14.69	0.903	2.192	1.46	3.22	0.90
D153	E	15.12	0.842	2.099	1.39	3.13	0.88
D154	S0	15.64	0.518	–	1.37	–	–
D155	S0	13.82	1.008	2.175	1.40	–	–
D156	E/S0	15.67*	0.669	–	–	–	–
D157	S0	15.71*	0.814	2.100	1.36	–	–
D160	SB0	14.34	0.976	2.258	1.48	–	–
D164	S0	–	1.279	–	–	3.05	0.86
D167	S0/E	13.69	1.129	2.307	1.43	–	–
D168	E	13.95	1.123	2.320	1.48	3.25	0.92
D170	SB0	14.51	0.921	2.146	1.39	2.99	0.95
D171	S0	15.38	0.808	–	1.40	–	–
D172	E	14.71	0.956	2.191	1.37	3.15	0.93
D173	S0	14.93	0.877	2.138	1.39	–	–
D174	E	14.66	0.999	2.247	1.44	3.24	0.92
D175	S0	14.18	1.027	2.234	1.49	3.21	0.90
D184	S0	15.78	–	–	–	2.99	0.81
D191	S0	15.44	0.786	1.947	1.34	–	–
D193	E	15.21	0.828	2.059	–	3.07	0.86
D194	E	13.33	1.192	2.394	1.56	3.29	0.92
D207	E	14.84*	0.894	2.154	1.43	3.12	0.87
D217	E	13.51	1.134	2.274	1.51	3.19	0.88
D240	E	12.72*	1.299	2.383	–	3.19	0.89
D245	S0	–	0.894	–	–	3.04	0.88

The values quoted have been corrected for redshift and reddening. The colours refer to an aperture size of 11 arcsec.

Table 13. Summary of astrophysical corrections.

Cluster	Colour	Reddening	Redshift	Aperture
Virgo	U-V	−0.02	0.00	–
	V-K	−0.03	−0.01	–
	J-K	−0.01	0.00	–
Coma	U-V	−0.02	0.00	0.01
	V-K	−0.03	−0.12	0.03
	J-K	−0.01	−0.08	0.02

Where the correction varies between individual galaxies, the mean correction has been quoted.

than 0.01 mag; the *J*- and *K*-band data are less well matched, the error being up to 0.02 mag. If the reddening estimates of Burstein & Heiles (1984) are reliable, then the statistical uncertainty of the mean reddening difference of the two clusters is considerably less than 0.01 mag. Experiment with a variety of galaxy SEDs suggests an uncertainty of 0.01 mag in the *K*-correction for the $U-V$ colour. However, in the *J*- and *K*-bands, the *K*-correction is clearly dependent on the star α Tau being a good match to the SED of an early-type galaxy, a factor which cannot yet be accurately assessed. We therefore assign an uncertainty of 0.02 mag to the $V-K$ and $J-K$ *K*-corrections. Finally, we estimate uncertainties of 0.005, 0.01 and 0.02 mag in the mean aperture corrections for the $U-V$, $V-K$ and $J-K$ colours respectively. Adding these systematic errors in quadrature, we estimate that the $U-V$, $V-K$ and $J-K$ colours are matched to better than 0.02, 0.03 and 0.04 mag respectively.

Values quoted for the total magnitude have been derived from Michard (1982) (Virgo) and from Godwin & Peach (1977, GP) (Coma), using our CCD photometry to place these magnitudes on a consistent system. The procedure adopted was as follows. For the Virgo cluster, we compared Michard's 60-arcsec aperture magnitudes with values derived from our own CCD photometry. We found an offset (after allowing for galactic extinction) of $V_{\rm Michard}-V_{\rm CCD}=0.02$ mag, with an rms scatter of 0.036 mag ($n=20$). This small correction was applied to the values of $V_{\rm T}$ quoted by Michard to derive those given in Table 11. It is not possible to compare values of $V_{\rm T}$ directly because the limited size of the CCD makes it difficult to determine the sky brightness with sufficient accuracy. In the Coma cluster, however, the outer isophotes of the galaxies fit well inside the CCD. Hence, for the galaxies that were well fitted by $r^{1/4}$-law profiles, we were able to determine $V_{\rm T}$ directly from our CCD data. These values were compared with the V_{25} photometry of GP. We found (including the effects of extinction and *K*-correction) an offset of $V_{\rm T}-V_{25}=-0.09$ mag ($\sigma=0.10$ mag, $n=13$). The $V_{\rm T}$ values quoted in Table 12 are derived by applying this zero-point offset to the photometry of GP. While this procedure aims to result in a homogeneous total magnitude system for both clusters, we believe that there could still be a residual offset of as much as 0.10 mag. For this reason, the distance modulus that is derived in Paper II directly from our CCD photometry via the D_V diameter is of far greater absolute accuracy. D_V is defined as the circular aperture diameter inside which the mean *V*-band surface brightness, corrected for seeing effect, extinction and cosmological effects, is 19.80 mag arcsec^{-2} (*cf.* Lucey & Carter 1988). This definition has been chosen so as to make our D_V parameters comparable with the D_n parameters determined by Dressler *et al.* (1987) from *B*-band photometry. The values quoted have been determined by interpolation between our aperture measurements. While such diameter parameters correlate extremely well with the velocity central dispersions of elliptical galaxies, their measurement is S0 galaxies is likely to be contaminated by disc light (*cf.* Dressler 1987). Therefore we might expect systematic differences to arise between the elliptical and S0 galaxies. Our measurements are in good agreement with the D_n parameters quoted by Dressler (1984, 1987). Intercomparison of the elliptical galaxy measurements in Virgo and Coma have an rms scatter of 0.018 and 0.014 mag respectively. There is no significant offset.

Morphological types presented in these tables are taken from Binggeli *et al.* (1985) and de Vaucouleurs, de Vaucouleurs & Corwin (1976), (for the Virgo cluster), and from Dressler (1980) (for the Coma cluster). Velocity dispersion indices have been taken from Dressler (1984, 1987).

7 CONCLUSIONS

We have presented V-band CCD photometry for a sample of 94 early-type galaxies in the Virgo and Coma clusters. A complementary data set of U-band CCD photometry of galaxies in both clusters, plus J- and K-band aperture photometry of galaxies in Coma has been obtained in order to test the universality and wavelength dependence of the colour–magnitude relation. In all, 603 observations have been made in photometric conditions. Our near-infrared observations of galaxies in the Coma cluster are complemented by J- and K-band observations of Virgo galaxies made by Persson *et al.* (1979, PFA).

In order that our comparison of the two clusters be reliable, it is important that our data are homogeneous. For this reason, our CCD observations alternated frequently between the two clusters. In the U- and V-bands, we estimate that our photometric zero-points agree to better than 0.01 mag. Our J- and K-band photometry has been matched to the system of PFA by observing a large number of galaxies in common. Since our zero-point, derived from the standard stars of Elias *et al.* (1982) (the same source as used by PFA), agrees directly with PFA's own photometry, we are confident that the J- and K-band magnitudes we adopt for the Coma and Virgo clusters share a common zero-point to better than 0.02 mag.

We have estimated random errors in our data by taking a large number of repeat observations. We find: in the U-band, rms scatters of 0.025 (Virgo, 60-arcsec aperture), and 0.030 (Coma, 13-arcsec aperture); in the V-band, 0.015 (Virgo, 60-arcsec aperture) and 0.021 (Coma, 13-arcsec aperture); in the J- and K-bands rms scatters of 0.026 and 0.027 respectively (Coma, 17-arcsec aperture). In the Virgo cluster, PFA estimate their J- and K-band random errors to be ~ 0.03 mag. Our estimates are supported by external comparisons with photometry from PFA (J- and K-bands), Sandage (1972, S72), Sandage & Visvanathan (1978, SV) and Michard (1982) (U- and V-bands).

In order to place the observed colours of galaxies in the two clusters in a consistent astrophysical system, corrections must be made for redshift, galactic extinction and aperture size. Redshift (K-) corrections have been estimated using a variety of early-type galaxy spectral energy distributions in order to establish the uncertainties. In all but our non-standard CCD U-band filter, we agree with the estimates published by Frogel *et al.* (1978, FPAM). A correction for galactic extinction of $A_B = 0.05$ mag has been applied in both clusters following the estimates of Burstein & Heiles (1984, BH). However, we find no evidence for a correlation between their estimates for individual galaxies and their deviation from the colour–magnitude relation. We have therefore applied only a mean correction to each cluster. Finally, a small correction has been made to reduce the colours obtained through 13-arcsec $(U-V)$ and 17-arcsec $(V-K$ and $J-K)$ apertures in Coma to an 11-arcsec aperture. This matches the physical size ($\sim 5\ h^{-1}$ kpc) of the 60-arcsec aperture used in the Virgo cluster. The total systematic uncertainties in these corrections are less than 0.01 mag $(U-V)$, 0.02 mag $(V-K)$ and 0.03 mag $(J-K)$. Therefore, the reduced (i.e. astrophysical) $U-V$, $V-K$ and $J-K$ colours presented in Tables 11 and 12 have zero-points matched to better than 0.02, 0.03 and 0.04 mag respectively.

Finally, we have derived a consistent total magnitude scheme for galaxies in the two clusters by using our CCD V-band data to zero-point the work of Michard (1982) and Godwin & Peach (1977) onto a consistent system. The relative distance modulus is, however, better determined using the photometric diameter technique proposed by Dressler *et al.* (1987). For both clusters we have derived a V-band diameter (D_V) directly from our CCD photometry. To our final data set we have added velocity dispersion parameters from Dressler (1984, 1987). Our analysis of the form of, and dispersion about, the colour–magnitude relations will be presented in Paper II.

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Precision photometry of early–type galaxies in the Coma and Virgo clusters: a test of the universality of the colour–magnitude relation – I. The data

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Table 2 — Uncorrected V-band Photometry in the Virgo Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. (″)													
				4.0	6.0	8.0	10.0	13.0	16.0	20.0	25.0	32.0	40.0	50.0	60.0	63.0	79.0
N4124	389P	2.4″	12/04/89	15.95	15.20	14.74	14.40	14.01	13.74	13.46	13.19	12.92	12.68	12.45	12.28	12.23	12.04
N4339	142P	2.0″	10/04/89	14.87	14.26	13.87	13.63	13.36	13.14	12.92	12.73	12.54	12.38	12.23	12.10	12.07	11.93
N4339	404P	1.4″	12/04/89	14.65	14.17	13.85	13.60	13.33	13.13	12.92	12.73	12.54	12.38	12.23	12.11	12.07	11.93
N4365	128P	2.4″	10/04/89	14.11	13.41	12.98	12.67	12.33	12.10	11.86	11.63	11.40	11.20	11.01	10.87	10.84	10.68
N4371	135P	2.0″	10/04/89	14.55	13.91	13.52	13.22	12.90	12.66	12.41	12.19	11.97	11.79	11.62	11.49	11.45	11.30
N4371	401P	1.4″	12/04/89	14.45	13.89	13.51	13.21	12.89	12.65	12.41	12.19	11.98	11.80	11.63	11.50	11.47	11.32
N4374	134P	1.9″	23/03/87	13.76	13.01	12.47	12.19	11.86	11.61	11.36	11.15	10.93	10.74	10.56	10.42	10.39	10.23
N4377	133P	2.5″	10/04/89	14.18	13.67	13.36	13.16	12.95	12.80	12.66	12.52	12.35	12.21	12.09	12.00	11.98	11.91
N4377	409P	2.1″	12/04/89	14.10	13.59	13.32	13.13	12.93	12.79	12.65	12.51	12.35	12.21	12.08	11.99	11.97	11.89
N4382	134P	1.8″	10/04/89	13.43	12.80	12.41	12.16	11.87	11.66	11.44	11.24	11.02	10.83	10.64	10.49		
N4382	136P	4.0″	10/04/89	14.02	13.24	12.78	12.40	12.04	11.78	11.52	11.29	11.06	10.86	10.66	10.51	10.47	10.28
N4382	178P	2.8″	10/04/89	13.64	12.98	12.58	12.23	11.92	11.69	11.46	11.25	11.03	10.84	10.65	10.50	10.45	10.27
N4387	107P	1.8″	23/03/87	15.00	14.42	14.07	13.75	13.46	13.25	13.06	12.89	12.72	12.60	12.49	12.42	12.41	12.34
N4387	146P	2.2″	10/04/89	15.12	14.47	14.08	13.79	13.48	13.27	13.07	12.89	12.72	12.60	12.50	12.43	12.41	12.35
N4406	132P	2.1″	10/04/89	13.89	13.25	12.84	12.53	12.21	11.97	11.72	11.49	11.24	11.03	10.82	10.66	10.62	10.43
N4435	138P	3.5″	10/04/89	14.36	13.67	13.16	12.84	12.51	12.28	12.06	11.87	11.69	11.53	11.39	11.28	11.25	11.14
N4435	411P	2.0″	12/04/89	14.04	13.42	13.01	12.72	12.43	12.22	12.03	11.86	11.69	11.54	11.41	11.31	11.28	11.18
N4442	140P	2.2″	10/04/89	13.75	13.16	12.80	12.49	12.18	11.97	11.76	11.57	11.37	11.22	11.08	10.99	10.96	10.87
N4442	413P	1.4″	12/04/89	13.58	13.05	12.71	12.46	12.17	11.96	11.76	11.57	11.38	11.23	11.09	10.99	10.97	10.88
N4458	179P	2.5″	20/04/88	15.12	14.55	14.18	13.98	13.74	13.54	13.34	13.17	12.97	12.80	12.65	12.54	12.51	12.38
N4458	126P	3.5″:	10/04/89	15.70	14.96	14.50	14.19	13.86	13.62	13.40	13.20	12.99	12.83	12.68	12.58	12.55	12.45
N4458	145P	2.0″	10/04/89	14.94	14.48	14.19	13.96	13.72	13.53	13.33	13.15	12.96	12.80	12.66	12.55	12.52	12.42
N4464	124P	2.8″	10/04/89	14.76	14.22	13.88	13.66	13.43	13.27	13.12	13.00	12.88	12.81	12.74	12.70	12.70	12.67
N4464	392P	2.0″	12/04/89	14.54	14.08	13.82	13.59	13.39	13.25	13.11	12.99	12.88	12.81	12.75	12.71	12.70	12.67
N4468	414P	1.4″	12/04/89	16.13	15.56	15.22	14.94	14.66	14.44	14.22	14.01	13.80	13.63	13.48	13.37	13.35	13.25
N4472	119P	2.3″	23/03/87	13.85	13.05	12.46	12.14	11.77	11.48	11.19	10.95	10.67	10.44	10.22	10.06	10.02	9.83
N4473	104P	1.7″	23/03/87	13.62	12.98	12.54	12.31	12.04	11.84	11.64	11.48	11.31	11.17	11.04	10.94	10.92	10.80

Table 2 (cont.) — Uncorrected V-band Photometry in the Virgo Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. (″)													
				4.0	6.0	8.0	10.0	13.0	16.0	20.0	25.0	32.0	40.0	50.0	60.0	63.0	79.0
N4476	139P	2.1″	10/04/89	15.28	14.59	14.22	13.92	13.64	13.44	13.26	13.10	12.95	12.82	12.71	12.63	12.61	12.52
N4476	416P	2.1″	12/04/89	15.24	14.62	14.23	13.94	13.66	13.46	13.28	13.12	12.96	12.84	12.73	12.65	12.63	12.55
N4478	148P	1.8″	20/04/88	14.55	13.91	13.43	13.17	12.86	12.61	12.40	12.16	11.97	11.84	11.73	11.66	11.64	11.57
N4486	101P	1.8″	23/03/87	14.43	13.67	13.06	12.70	12.27	11.91	11.56	11.27	10.95	10.69	10.47	10.29	10.25	10.05
N4486	116P	2.0″	23/03/87	14.46	13.68	13.06	12.71	12.27	11.92	11.56	11.27	10.95	10.69	10.46	10.29	10.25	10.05
N4486	128P	2.4″	23/03/87	14.47	13.68	13.06	12.70	12.27	11.91	11.56	11.27	10.95	10.69	10.46	10.28	10.24	10.05
N4486	122P	2.6″	10/04/89	14.43	13.67	13.14	12.74	12.29	11.94	11.59	11.27	10.95	10.69	10.46	10.29	10.24	10.05
N4486	144P	2.6″	10/04/89	14.36	13.62	13.14	12.71	12.29	11.95	11.59	11.27	10.95	10.69	10.46	10.28	10.24	10.04
N4486	297P	1.4″	11/04/89	14.27	13.60	13.08	12.70	12.24	11.90	11.57	11.26	10.94	10.69	10.46	10.28	10.24	10.04
N4486	309P	2.0″	11/04/89	14.33	13.59	13.08	12.69	12.24	11.91	11.57	11.26	10.94	10.69	10.45	10.28	10.24	10.04
N4486	316P	2.0″	11/04/89	14.42	13.63	13.09	12.72	12.25	11.92	11.57	11.26	10.95	10.69	10.46	10.29	10.24	10.05
N4550	127P	2.5″	10/04/89	14.87	14.26	13.79	13.49	13.16	12.91	12.68	12.47	12.28	12.14	12.02	11.94	11.92	11.84
N4550	394P	1.6″	12/04/89	14.78	14.18	13.78	13.47	13.15	12.90	12.68	12.48	12.29	12.15	12.03	11.96	11.94	11.86
N4551	395P	2.1″	12/04/89	15.01	14.45	14.07	13.81	13.50	13.27	13.05	12.85	12.66	12.51	12.38	12.29	12.27	12.19
N4552	131P	1.2″	23/03/87	13.43	12.85	12.43	12.20	11.93	11.71	11.50	11.33	11.15	10.99	10.85	10.73	10.70	10.57
N4552	146P	1.8″	20/04/88	13.53	12.91	12.47	12.24	11.96	11.74	11.52	11.35	11.16	11.01	10.86	10.74	10.71	10.58
N4552	157P	1.8″	20/04/88	13.52	12.90	12.47	12.23	11.95	11.73	11.52	11.35	11.16	11.00	10.86	10.74	10.71	10.58
N4552	170P	2.5″	20/04/88	13.58	12.92	12.47	12.23	11.95	11.73	11.52	11.34	11.16	11.00	10.85	10.74	10.71	10.57
N4552	178P	2.5″	20/04/88	13.63	12.95	12.48	12.24	11.96	11.74	11.53	11.35	11.16	11.01	10.86	10.75	10.72	10.58
N4552	184P	3.1″	20/04/88	13.64	12.95	12.48	12.24	11.96	11.73	11.52	11.34	11.15	11.00	10.85	10.73	10.70	10.57
N4552	121P	3.5″	10/04/89	13.90	13.21	12.75	12.40	12.05	11.81	11.58	11.37	11.17	11.01	10.86	10.75	10.72	10.58
N4552	131P	2.9″	10/04/89	13.70	12.99	12.56	12.29	11.97	11.75	11.53	11.34	11.16	11.00	10.85	10.74	10.71	10.58
N4552	143P	2.1″	10/04/89	13.45	12.89	12.51	12.24	11.94	11.73	11.52	11.34	11.15	11.00	10.85	10.73	10.70	10.57
N4552	180P	2.3″	10/04/89	13.46	12.89	12.50	12.24	11.94	11.72	11.52	11.33	11.15	11.00	10.85	10.74	10.71	10.58
N4552	375P	2.0″	12/04/89	13.55	12.91	12.47	12.23	11.95	11.73	11.51	11.34	11.16	11.00	10.86	10.74	10.71	10.58
N4552	387P	3.3″	12/04/89	13.77	13.03	12.59	12.31	11.98	11.76	11.54	11.35	11.16	11.00	10.86	10.74	10.71	10.58
N4552	407P	1.6″	12/04/89	13.41	12.83	12.46	12.21	11.93	11.72	11.52	11.34	11.16	11.01	10.86	10.75	10.72	10.59
N4552	432P	2.7″	12/04/89	13.61	12.95	12.54	12.27	11.96	11.74	11.53	11.35	11.16	11.01	10.86	10.75	10.72	10.59

Table 2 (cont.) — Uncorrected V-band Photometry in the Virgo Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. (″)													
				4.0	6.0	8.0	10.0	13.0	16.0	20.0	25.0	32.0	40.0	50.0	60.0	63.0	79.0
N4564	130P	3.0″:	10/04/89	14.46	13.76	13.31	13.03	12.72	12.51	12.31	12.13	11.95	11.80	11.67	11.57	11.54	11.44
N4564	396P	2.4″	12/04/89	13.96	13.43	13.11	12.88	12.63	12.45	12.27	12.11	11.94	11.80	11.66	11.57	11.54	11.43
N4621	129P	4.8″	10/04/89	11.36	13.58	13.07	12.72	12.33	12.05	11.78	11.54	11.30	11.10	10.93	10.79	10.75	10.60
N4621	397P	2.0″	12/04/89	13.49	12.93	12.61	12.33	12.07	11.86	11.66	11.46	11.26	11.08	10.91	10.78	10.75	10.60
N4636	141P	2.2″	10/04/89	14.65	13.85	13.33	13.00	12.60	12.32	12.04	11.78	11.53	11.31	11.10	10.93	10.89	10.70
N4636	179P	4.0″	10/04/89	14.91	14.07	13.57	13.14	12.71	12.40	12.10	11.82	11.55	11.32	11.10	10.94	10.89	10.70
N4660	123P	2.9″	10/04/89	13.84	13.26	12.91	12.65	12.40	12.23	12.06	11.91	11.77	11.66	11.56	11.50	11.48	11.41
N4660	177P	2.3″	10/04/89	13.67	13.14	12.83	12.61	12.38	12.21	12.05	11.91	11.76	11.66	11.56	11.50	11.48	11.41
N4660	399P	1.5″	12/04/89	13.52	13.04	12.76	12.58	12.36	12.21	12.05	11.91	11.77	11.66	11.57	11.51	11.49	11.42
N4660	426P	2.3″	12/04/89	13.64	13.13	12.82	12.59	12.37	12.21	12.06	11.91	11.78	11.67	11.58	11.51	11.50	11.43
N4697	424P	2.9″	12/04/89	13.94	13.25	12.82	12.45	12.10	11.85	11.60	11.36	11.11	10.90	10.70	10.55	10.50	10.32

Table 3 — Uncorrected U-band Photometry in the Virgo Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. (″)													
				4.0	6.0	8.0	10.0	13.0	16.0	20.0	25.0	32.0	40.0	50.0	60.0	63.0	79.0
N4124	390P	2.8″	12/04/89	17.32	16.44	15.91	15.57	15.17	14.89	14.61	14.32	14.03	13.77	13.53	13.34	13.29	13.07
N4339	406P	1.8″	12/04/89	16.29	15.70	15.36	15.08	14.80	14.59	14.37	14.17	13.97	13.80	13.64	13.48	13.45	13.29
N4365	197P	2.7″:	10/04/89	15.85	15.10	14.63	14.33	13.97	13.71	13.46	13.23	12.98	12.77	12.57	12.42	12.38	12.22
N4365	391P	2.5″:	12/04/89	15.82	15.11	14.66	14.29	13.94	13.69	13.44	13.21	12.96	12.74	12.54	12.39	12.35	12.18
N4371	205P	3.0″:	10/04/89	16.24	15.52	15.09	14.79	14.44	14.19	13.94	13.72	13.50	13.31	13.15	13.02	12.99	12.84
N4371	402P	1.9″	12/04/89	16.19	15.50	15.07	14.78	14.43	14.18	13.93	13.70	13.48	13.29	13.12	12.99	12.95	12.80
N4374	136P	2.0″	23/03/87	15.56	14.78	14.20	13.89	13.54	13.27	13.00	12.78	12.54	12.33	12.14	11.99	11.95	11.78
N4374	283P	1.8″	21/04/88	15.48	14.72	14.22	13.89	13.52	13.26	12.99	12.76	12.52	12.32	12.13	11.98	11.94	11.77
N4377	206P	3.3″	10/04/89	15.89	15.25	14.87	14.64	14.40	14.24	14.08	13.92	13.74	13.58	13.42	13.32	13.30	13.20
N4377	410P	2.1″	12/04/89	15.66	15.10	14.81	14.59	14.37	14.22	14.06	13.90	13.72	13.56	13.42	13.33	13.30	13.21:
N4382	207P	3.5″	10/04/89	15.05	14.30	13.88	13.55	13.23	13.00	12.79	12.59	12.38	12.20	12.02	11.88	11.84	11.65
N4382	412P	2.0″	12/04/89	14.78	14.13	13.77	13.49	13.20	12.99	12.78	12.58	12.37	12.19	12.02	11.87	11.83	11.65
N4387	109P	2.3″	23/03/87	16.73	16.06	15.56	15.30	14.99	14.75	14.53	14.35	14.16	14.01	13.88	13.80	13.78	13.70
N4387	203P	2.4″	10/04/89	16.72	15.99	15.56	15.29	14.95	14.73	14.52	14.33	14.15	14.01	13.90	13.83	13.82	13.73:
N4387	274P	2.1″	11/04/89	16.65	15.99	15.57	15.27	14.95	14.72	14.51	14.33	14.14	14.01	13.90	13.82:	13.80:	
N4406	209P	3.0″:	10/04/89	15.55	14.89	14.46	14.16	13.83	13.57	13.31	13.06	12.81	12.58	12.36	12.19	12.15	11.92
N4406	272P	1.6″:	11/04/89	15.50	14.83	14.43	14.16	13.82	13.58	13.32	13.08	12.82	12.60	12.39	12.22	12.18	11.97
N4435	292P	1.9″:	11/04/89	15.54	14.92	14.48	14.21	13.92	13.72	13.52	13.33	13.14	12.98	12.82	12.71	12.68	12.55
N4442	293P	1.9″	11/04/89	15.40	14.78	14.41	14.10	13.79	13.56	13.34	13.13	12.92	12.75	12.59	12.48	12.45	12.34
N4458	198P	2.6″	10/04/89	16.46	15.91	15.58	15.35	15.08	14.88	14.67	14.49	14.29	14.13	13.98	13.88	13.86	13.76
N4464	199P	2.0″	10/04/89	15.97	15.51	15.23	15.04	14.82	14.67	14.52	14.39	14.26	14.17	14.09	14.03	14.01	13.95
N4464	393P	2.2″	12/04/89	16.07	15.57	15.26	15.04	14.82	14.66	14.51	14.38	14.25	14.16	14.09	14.01	14.00	13.95
N4468	294P	1.9″:	11/04/89	17.55	16.98	16.59	16.30	15.98	15.73	15.46	15.23	14.99	14.78	14.61	14.47:	14.44:	
N4468	415P	3.0″:	12/04/89	17.55	16.94	16.54	16.27	15.96	15.71	15.43	15.17	14.99	14.81	14.66	14.54:	14.52:	
N4472	121P	2.3″	23/03/87	15.59	14.79	14.18	13.85	13.47	13.16	12.86	12.61	12.32	12.08	11.85	11.68	11.64	11.44
N4473	106P	3.1″	23/03/87	15.34	14.66	14.18	13.93	13.64	13.42	13.21	13.03	12.85	12.69	12.55	12.44	12.41	12.27
N4476	417P	3.0″:	12/04/89	16.50	15.80	15.38	15.08	14.79	14.59	14.40	14.22	14.05	13.91	13.77	13.67	13.65	13.54

Table 3 (cont.) — Uncorrected U-band Photometry in the Virgo Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. (″) 4.0	6.0	8.0	10.0	13.0	16.0	20.0	25.0	32.0	40.0	50.0	60.0	63.0	79.0
N4486	103P	2.0″	23/03/87	15.70	15.10	14.58	14.27	13.88	13.55	13.21	12.90	12.56	12.29	12.06	11.89	11.84	11.65
N4486	118P	2.2″	23/03/87	15.73	15.10	14.58	14.27	13.87	13.54	13.20	12.90	12.55	12.28	12.05	11.87	11.82	11.62
N4486	130P	2.5″	23/03/87	15.73	15.09	14.57	14.26	13.87	13.53	13.19	12.89	12.54	12.27	12.05	11.87	11.82	11.62
N4486	200P	1.9″	10/04/89	15.59	15.02	14.60	14.25	13.84	13.53	13.19	12.85	12.52	12.26	12.03	11.86	11.81	11.61
N4486	208P	3.1″	10/04/89	15.74	15.08	14.63	14.26	13.84	13.54	13.19	12.86	12.53	12.27	12.04	11.86	11.81	11.61
N4486	273P	1.7″	11/04/89	15.67	15.05	14.62	14.26	13.85	13.54	13.20	12.86	12.53	12.27	12.04	11.86	11.82	11.62
N4486	296P	1.8″	11/04/89	15.64	15.04	14.60	14.26	13.85	13.53	13.20	12.87	12.54	12.27	12.04	11.87	11.83	11.63
N4486	315P	3.0″	11/04/89	15.74	15.06	14.63	14.25	13.84	13.52	13.19	12.86	12.52	12.26	12.03	11.86	11.81	11.60
N4550	290P	1.8″:	11/04/89	16.43	15.69	15.20	14.90	14.57	14.31	14.05	13.84	13.62	13.45	13.32	13.24	13.22	13.12
N4551	291P	1.9″	11/04/89	16.61	16.02	15.59	15.31	15.00	14.77	14.54	14.34	14.14	13.98	13.85	13.76	13.74	13.65:
N4552	133P	2.0″	23/03/87	15.31	14.64	14.17	13.93	13.64	13.40	13.18	12.99	12.79	12.62	12.46	12.32	12.29	12.13
N4552	147P	2.4″	20/04/88	15.17	14.58	14.19	13.92	13.61	13.39	13.18	12.98	12.78	12.62	12.46	12.34	12.31	12.17
N4552	156P	2.3″	20/04/88	15.15	14.58	14.16	13.89	13.60	13.38	13.16	12.96	12.76	12.60	12.44	12.31	12.28	12.14
N4552	282P	1.8″	21/04/88	15.10	14.53	14.17	13.90	13.61	13.39	13.17	12.97	12.78	12.61	12.45	12.33	12.30	12.15
N4552	196P	2.7″	10/04/89	15.23	14.62	14.19	13.92	13.62	13.40	13.18	12.97	12.77	12.60	12.44	12.32	12.29	12.13
N4552	204P	2.5″	10/04/89	15.22	14.60	14.22	13.90	13.60	13.39	13.17	12.96	12.77	12.60	12.44	12.31	12.28	12.14
N4552	271P	1.6″	11/04/89	15.09	14.51	14.16	13.90	13.59	13.38	13.17	12.97	12.77	12.60	12.45	12.32	12.29	12.14
N4552	289P	1.8″	11/04/89	15.06	14.53	14.16	13.90	13.61	13.39	13.18	12.98	12.79	12.62	12.46	12.34	12.30	12.16
N4552	374P	2.5″	12/04/89	15.36	14.66	14.27	13.95	13.62	13.39	13.17	12.97	12.77	12.60	12.44	12.31	12.28	12.13
N4552	388P	2.5″	12/04/89	15.21	14.58	14.19	13.91	13.61	13.38	13.16	12.96	12.76	12.60	12.44	12.31	12.28	12.14
N4552	408P	2.0″	12/04/89	15.12	14.52	14.16	13.90	13.59	13.38	13.17	12.97	12.77	12.60	12.44	12.32	12.29	12.15
N4552	431P	3.3″	12/04/89	15.36	14.72	14.29	13.99	13.66	13.43	13.20	12.99	12.79	12.62	12.45	12.33	12.30	12.15
N4621	201P	2.2″	10/04/89	15.22	14.65	14.28	14.03	13.73	13.51	13.29	13.07	12.85	12.65	12.46	12.32	12.28	12.12
N4636	295P	1.8″	11/04/89	16.16	15.46	14.97	14.61	14.22	13.94	13.64	13.38	13.10	12.87	12.65	12.47	12.43	12.23
N4636	398P	2.0″	12/04/89	16.16	15.45	14.96	14.58	14.19	13.90	13.63	13.35	13.08	12.85	12.62	12.43	12.39	12.19
N4660	202P	2.3″:	10/04/89	15.39	14.77	14.41	14.19	13.93	13.75	13.56	13.40	13.23	13.09	12.97	12.89	12.87	12.76
N4660	400P	2.0″:	12/04/89	15.24	14.71	14.39	14.16	13.91	13.73	13.55	13.39	13.22	13.10	12.98	12.90	12.88	12.78
N4697	425P	3.3″	12/04/89	15.71	14.93	14.41	14.08	13.69	13.41	13.12	12.86	12.59	12.36	12.14	11.97	11.93	11.73

Table 4 — Uncorrected V-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia.									
				4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″	32.0″
D10	330P	1.6″	11/04/89	17.70	17.31	17.05	16.89	16.70	16.58:	16.54:			
D31	329P	1.8″:	11/04/89	15.66	15.08	14.73	14.48	14.21	14.01	13.96	13.82	13.63	13.44
D49	328P	1.7″:	11/04/89	15.24	14.80	14.55	14.34	14.14	14.00	13.97	13.86	13.73	13.58
D64	212P	1.5″	20/04/88	17.35	16.96	16.71	16.53	16.35	16.22	16.18	16.08	15.96:	
D67	161P	2.5″	10/04/89	16.78	16.29	16.01	15.85	15.70	15.61	15.58	15.53	15.48	15.44:
D68	302P	1.4″	11/04/89	16.44	16.03	15.78	15.60	15.42	15.30	15.27	15.18	15.06	14.96
D69	302P	1.4″	11/04/89	15.87	15.43	15.18	15.03	14.87	14.76	14.73	14.65	14.56	14.47
D70	302P	1.4″	11/04/89	16.10	15.78	15.60	15.47	15.33	15.24	15.21	15.15	15.06	14.98
D71	185P	2.7″	20/04/88	17.78	17.17	16.80	16.62	16.42	16.27	16.24	16.13	16.02	15.88
D71	302P	1.4″	11/04/89	17.46	17.02	16.77	16.59	16.42	16.30	16.27	16.19	16.11:	
D72	185P	2.7″	20/04/88	16.45	15.88	15.55	15.40	15.25	15.14	15.12	15.05	14.99:	
D78	327P	1.7″	11/04/89	15.64	15.17	14.94	14.76	14.58	14.46	14.43	14.33	14.22	14.10
D79	153P	1.6″	20/04/88	15.75	15.29	15.00	14.85	14.67	14.53	14.50	14.41	14.32	14.23
D79	326P	1.8″	11/04/89	15.63	15.22	14.97	14.81	14.63	14.50	14.47	14.39	14.30	14.22
D81	326P	1.8″	11/04/89	16.63	16.28	16.06	15.91	15.74	15.63	15.60	15.51	15.4[illegible]:	
D84	212P	1.5″	20/04/88	16.57	16.12	15.86	15.71	15.56	15.44	15.40	15.32	15.22	15.13
D85	212P	1.5″	20/04/88	17.59	17.20	16.99	16.86	16.74	16.69:	16.68:	16.65:		
D87	152P	1.6″	20/04/88	17.06	16.67	16.42	16.31	16.18	16.10	16.08	16.03	15.97	15.92:
D87	325P	2.3″	11/04/89	17.09	16.64	16.43	16.29	16.16	16.08	16.06	16.02:		
D87	438P	2.8″	12/04/89	17.28	16.76	16.49	16.34	16.19	16.10	16.08	16.04:		
D91	185P	2.7″	20/04/88	15.95	15.39	15.06	14.91	14.75	14.64	14.61	14.54	14.46	14.37
D95	177P	3.0″	20/04/88	16.00	15.50	15.23	15.09	14.95	14.84	14.82	14.75	14.67	14.60
D96	211P	1.5″	20/04/88	16.04	15.74	15.56	15.42	15.29	15.19	15.16	15.08	14.98	14.88
D96	324P	1.9″:	11/04/89	16.11	15.74	15.55	15.43	15.29	15.19	15.16	15.09	15.01	14.92:
D103	137P	1.8″	23/03/87	15.59	15.25	15.07	14.94	14.82	14.73	14.71	14.65	14.56	14.46
D103	213P	1.5″	20/04/88	15.60	15.27	15.09	14.96	14.84	14.75	14.73	14.66	14.57	14.46
D103	323P	1.9″	11/04/89	15.76	15.34	15.12	14.98	14.84	14.75	14.73	14.66	14.58	14.48
D104	213P	1.5″	20/04/88	16.05	15.68	15.47	15.33	15.19	15.09	15.07	15.00	14.92	14.83
D104	221P	1.6″	20/04/88	16.07	15.69	15.49	15.35	15.22	15.13	15.11	15.06	14.99	14.94
D104	322P	2.3″	11/04/89	16.25	15.78	15.52	15.37	15.21	15.11	15.09	15.03	14.96	14.89

Table 4 (cont.) — Uncorrected V-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia.									
				4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″	32.0″
D105	213P	1.5″	20/04/88	15.74	15.29	15.02	14.80	14.60	14.47	14.43	14.33	14.21	13.99
D105	323P	1.9″	11/04/89	15.86	15.35	15.05	14.82	14.61	14.48	14.45	14.35	14.24	14.12
D106	213P	1.5″	20/04/88	16.47	16.14	15.95	15.83	15.71	15.63	15.61	15.55	15.48	15.37:
D106	323P	1.9″	11/04/89	16.63	16.21	16.00	15.86	15.73	15.67	15.65	15.61	15.56:	
D107	137P	1.8″	23/03/87	17.01	16.52	16.24	16.05	15.86	15.74	15.71	15.63:	15.54:	
D107	213P	1.5″	20/04/88	16.97	16.53	16.25	16.06	15.87	15.75	15.71	15.62	15.52	15.42:
D107	323P	1.9″	11/04/89	17.02	16.54	16.27	16.07	15.90	15.78	15.74	15.67	15.59:	
D110	205P	1.6″	20/04/88	16.22	15.83	15.56	15.42	15.25	15.11	15.07	14.98	14.89	14.78
D111	205P	1.6″	20/04/88	16.95	16.52	16.24	16.10	15.93	15.80	15.77	15.68	15.59	15.48
D116	162P	2.7″	10/04/89	16.93	16.43	16.09	15.89	15.67	15.52	15.48	15.37	15.25	15.13
D116	435P	2.2″	12/04/89	16.74	16.27	16.01	15.82	15.63	15.50	15.46	15.37	15.26	15.17:
D117	304P	1.3″	11/04/89	16.91	16.49	16.25	16.09	15.92	15.81	15.78	15.72	15.65	15.59:
D118	304P	1.3″	11/04/89	16.06	15.61	15.35	15.18	14.98	14.85	14.81	14.72	14.61	14.52
D119	435P	2.2″	12/04/89	16.70	16.26	16.03	15.89	15.74	15.64	15.61	15.55	15.50	15.48:
D122	217P	1.4″	20/04/88	16.41	16.08	15.90	15.74	15.59	15.48	15.45	15.37	15.29	15.22:
D122	307P	1.9″	11/04/89	16.47	16.09	15.89	15.76	15.60	15.49	15.46	15.39	15.32	15.26
D122	332P	2.1″	11/04/89	16.53	16.15	15.91	15.77	15.62	15.50	15.47	15.40	15.31	15.25:
D123	221P	1.6″	20/04/88	17.25	16.78	16.47	16.27	16.03	15.86	15.81	15.72	15.60:	15.49:
D123	322P	2.3″	11/04/89	17.47	16.88	16.55	16.29	16.04	15.88	15.84	15.74	15.63:	
D124	221P	1.6″	20/04/88	16.04	15.59	15.33	15.16	14.98	14.87	14.84	14.77	14.70	14.63
D124	322P	2.3″	11/04/89	16.19	15.69	15.39	15.19	15.00	14.88	14.84	14.77	14.69	14.63
D125	221P	1.6″	20/04/88	16.33	16.04	15.90	15.82	15.74	15.70	15.69	15.66	15.63:	15.61:
D125	322P	2.3″	11/04/89	16.51	16.13	15.94	15.83	15.73	15.67	15.65	15.62	15.56:	
D126	113P	2.4″	23/03/87	17.25	16.71	16.43	16.26	16.10	16.00	15.98	15.93	15.89	15.87
D126	222P	1.5″	20/04/88	17.56	16.88	16.55	16.30	16.12	16.00	15.98	15.92	15.84:	
D126	159P	2.1″	10/04/89	17.38	16.79	16.46	16.28	16.10	15.99	15.97	15.91	15.85:	
D126	165P	2.2″	10/04/89	17.38	16.81	16.47	16.28	16.11	16.00	15.97	15.92	15.86	15.82:
D126	301P	1.6″	11/04/89	17.06	16.64	16.38	16.22	16.07	15.97	15.95	15.90	15.86	15.82:

Table 4 (cont.) — Uncorrected V-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia.									
				4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″	32.0″
D126	321P	2.3″	11/04/89	17.26	16.71	16.44	16.24	16.07	15.96	15.94	15.88:	15.81:	
D126	331P	2.3″	11/04/89	17.26	16.74	16.45	16.27	16.10	16.00	15.98	15.93	15.88:	
D126	440P	2.5″	12/04/89	17.31	16.75	16.44	16.26	16.08	15.97	15.94	15.88:	15.81:	
D127	113P	2.4″	23/03/87	17.31	16.89	16.68	16.51	16.37	16.27	16.24	16.17	16.09	16.00
D127	159P	2.1″	10/04/89	17.54	17.01	16.72	16.56	16.40	16.30	16.28	16.22	16.15:	
D127	165P	2.2″	10/04/89	17.51	17.00	16.73	16.57	16.42	16.33	16.30	16.25	16.20	16.16:
D127	301P	1.6″	11/04/89	17.19	16.86	16.64	16.52	16.40	16.33	16.31	16.27	16.24	16.22:
D127	321P	2.3″	11/04/89	17.38	16.95	16.72	16.55	16.42	16.34	16.32	16.27:	16.23:	
D127	331P	2.3″	11/04/89	17.38	16.95	16.70	16.55	16.41	16.33	16.31	16.27:	16.22:	
D127	440P	2.5″	12/04/89	17.45	16.96	16.72	16.56	16.42	16.34	16.32	16.28:	16.24:	
D128	113P	2.4″	23/03/87	16.95	16.57	16.34	16.20	16.07	15.98	15.96	15.91	15.85	15.81
D128	159P	2.1″	10/04/89	17.11	16.68	16.40	16.26	16.11	16.03	16.01	15.97	15.94:	15.93:
D128	165P	2.2″	10/04/89	17.09	16.66	16.42	16.25	16.11	16.03	16.02	15.98	15.94	15.93:
D128	301P	1.6″	11/04/89	16.85	16.51	16.31	16.21	16.09	16.02	16.00	15.97	15.94	15.93:
D128	321P	2.3″	11/04/89	17.01	16.59	16.37	16.23	16.10	16.03	16.02	15.97	15.94:	15.92:
D128	331P	2.3″	11/04/89	16.96	16.59	16.37	16.23	16.09	16.02	16.00	15.96	15.91:	15.87:
D128	440P	2.5″	12/04/89	17.04	16.61	16.37	16.23	16.09	16.01	15.99	15.95	15.91:	15.88:
D129	113P	2.4″	23/03/87	16.16	15.38	14.93	14.58	14.25	14.00	13.95	13.78	13.56	13.34
D129	159P	2.1″	10/04/89	16.24	15.46	14.96	14.64	14.28	14.04	13.96	13.79	13.57	13.35
D129	165P	2.2″	10/04/89	16.19	15.44	14.96	14.63	14.28	14.03	13.96	13.79	13.57	13.34
D129	301P	1.6″	11/04/89	16.01	15.30	14.88	14.57	14.24	14.02	13.94	13.78	13.57	13.34
D129	321P	2.3″	11/04/89	16.10	15.40	14.93	14.60	14.26	14.02	13.95	13.78	13.57	13.34
D129	331P	2.3″	11/04/89	16.18	15.40	14.92	14.61	14.26	14.02	13.95	13.78	13.57	13.35
D129	440P	2.5″	12/04/89	16.24	15.44	14.92	14.61	14.28	14.03	13.96	13.78	13.57	13.35
D130	113P	2.4″	23/03/87	15.91	15.47	15.24	15.10	14.97	14.89	14.86	14.81	14.75	14.70
D130	321P	2.3″	11/04/89	15.94	15.49	15.25	15.10	14.96	14.88	14.85	14.80	14.74	14.68
D130	331P	2.3″	11/04/89	16.00	15.51	15.28	15.11	14.98	14.89	14.88	14.83	14.77	14.73
D130	440P	2.5″	12/04/89	15.99	15.51	15.27	15.12	14.98	14.90	14.88	14.83	14.78	14.74

Table 4 (cont.) — Uncorrected V-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia.									
				4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″	32.0″
D131	113P	2.4″	23/03/87	16.13	15.69	15.45	15.25	15.05	14.91	14.88	14.78	14.65	14.53
D131	159P	2.1″	10/04/89	16.26	15.78	15.49	15.28	15.07	14.92	14.88	14.77	14.64	14.52
D131	165P	2.2″	10/04/89	16.25	15.78	15.49	15.28	15.07	14.92	14.87	14.77	14.63	14.51
D131	301P	1.6″	11/04/89	15.99	15.62	15.39	15.22	15.03	14.89	14.85	14.75	14.61	14.49
D131	321P	2.3″	11/04/89	16.15	15.69	15.44	15.26	15.06	14.92	14.87	14.77	14.64	14.52
D131	331P	2.3″	11/04/89	16.18	15.71	15.43	15.26	15.06	14.91	14.87	14.76	14.64	14.52
D131	440P	2.5″	12/04/89	16.18	15.72	15.45	15.25	15.06	14.91	14.87	14.77	14.64	14.52
D132	113P	2.4″	23/03/87	17.09	16.67	16.46	16.28	16.12	16.01	15.97	15.88	15.76	15.65
D132	159P	2.1″	10/04/89	17.30	16.76	16.46	16.29	16.12	15.99	15.95	15.87:	15.76:	
D132	165P	2.2″	10/04/89	17.18	16.73	16.47	16.30	16.13	16.01	15.98	15.90	15.79	15.69:
D132	301P	1.6″	11/04/89	16.97	16.58	16.38	16.25	16.11	16.01	15.97	15.90	15.82	15.74:
D132	305P	1.4″	11/04/89	16.95	16.57	16.36	16.23	16.07	15.96	15.92	15.84	15.72	15.62:
D132	321P	2.3″	11/04/89	17.07	16.66	16.42	16.25	16.08	15.98	15.95	15.86	15.76:	
D132	331P	2.3″	11/04/89	17.12	16.67	16.45	16.28	16.13	16.02	15.99	15.91	15.82:	
D132	440P	2.5″	12/04/89	17.13	16.67	16.44	16.29	16.12	16.00	15.97	15.88:	15.77:	
D133	305P	1.4″	11/04/89	15.74	15.39	15.17	15.03	14.89	14.81	14.79	14.73	14.67	14.59
D134	320P	1.8″	11/04/89	17.08	16.76	16.59	16.48	16.39	16.35	16.33	16.30:	16.27:	
D134	439P	2.8″	12/04/89	17.40	16.92	16.68	16.55	16.44	16.38:	16.36:	16.33:		
D135	320P	1.8″	11/04/89	17.18	16.79	16.58	16.41	16.26	16.18	16.15	16.10	16.05:	
D135	439P	2.8″	12/04/89	17.50	16.94	16.65	16.48	16.30	16.20	16.17	16.12:		
D136	320P	1.8″	11/04/89	16.36	16.03	15.89	15.80	15.73	15.69	15.68	15.65	15.62:	
D136	439P	2.8″	12/04/89	16.64	16.18	15.97	15.85	15.75	15.70	15.69	15.66	15.62:	
D143	149P	1.6″	20/04/88	16.14	15.58	15.23	15.00	14.73	14.54	14.48	14.35	14.17	14.00
D143	436P	2.9″	12/04/89	16.36	15.67	15.30	15.01	14.73	14.53	14.48	14.34	14.17	14.00
D144	162P	2.7″	10/04/89	16.21	15.70	15.36	15.17	14.97	14.84	14.80	14.70	14.57	14.45
D144	435P	2.2″	12/04/89	16.05	15.54	15.26	15.10	14.92	14.81	14.78	14.69	14.57	14.46
D145	149P	1.6″	20/04/88	16.66	16.16	15.88	15.71	15.51	15.37	15.33	15.24	15.12	15.02
D145	162P	2.7″	10/04/89	16.89	16.33	15.99	15.77	15.55	15.39	15.35	15.25	15.12	15.03
D145	435P	2.2″	12/04/89	16.75	16.19	15.89	15.71	15.50	15.37	15.33	15.24		
D145	436P	2.9″	12/04/89	16.79	16.27	15.91	15.71	15.51	15.37	15.33	15.23		
D147	435P	2.2″	12/04/89	17.11	16.59	16.29	16.11	15.89	15.74	15.70	15.59	15.46	15.34:

Table 4 (cont.) — Uncorrected V-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. 4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″	32.0″
D148	110P	1.9″	23/03/87	15.32	14.61	14.13	13.88	13.60	13.38	13.33	13.17	12.99	12.79
D148	217P	1.4″	20/04/88	15.20	14.53	14.16	13.87	13.59	13.38	13.33	13.18	12.99	12.79
D148	307P	1.9″	11/04/89	15.20	14.54	14.14	13.88	13.59	13.39	13.33	13.18	12.99	12.79
D148	332P	2.1″	11/04/89	15.35	14.64	14.15	13.91	13.62	13.40	13.35	13.19	13.01	12.81
D150	110P	1.9″	23/03/87	16.64	16.19	15.89	15.74	15.57	15.45	15.43	15.36	15.31	15.28
D150	217P	1.4″	20/04/88	16.50	16.13	15.90	15.74	15.57	15.45	15.42	15.36	15.30	15.24:
D150	319P	1.9″	11/04/89	16.61	16.17	15.89	15.73	15.56	15.45	15.42	15.36	15.29	15.24:
D151	110P	1.9″	23/03/87	16.13	15.66	15.34	15.17	14.97	14.82	14.78	14.68	14.57	14.46
D151	217P	1.4″	20/04/88	16.03	15.61	15.35	15.18	14.97	14.82	14.78	14.68	14.56	14.46
D152	113P	2.4″	23/03/87	16.68	16.12	15.84	15.63	15.41	15.28	15.24	15.15	15.04	14.97
D152	222P	1.5″	20/04/88	16.53	16.09	15.80	15.62	15.43	15.28	15.24	15.14	15.04	14.98
D152	159P	2.1″	10/04/89	16.76	16.19	15.89	15.65	15.43	15.28	15.25	15.15	15.05	14.99:
D152	165P	2.2″	10/04/89	16.66	16.18	15.87	15.66	15.43	15.28	15.24	15.14	15.03	14.97
D152	301P	1.6″	11/04/89	16.45	16.03	15.79	15.60	15.40	15.26	15.22	15.13	15.03	14.97
D152	318P	1.8″	11/04/89	16.53	16.07	15.80	15.62	15.40	15.26	15.22	15.13	15.03	14.96
D152	321P	2.3″	11/04/89	16.55	16.09	15.83	15.61	15.42	15.27	15.22	15.13	15.02	14.94:
D152	331P	2.3″	11/04/89	16.61	16.11	15.83	15.63	15.42	15.27	15.24	15.14	15.04	14.97:
D152	440P	2.5″	12/04/89	16.64	16.12	15.83	15.63	15.41	15.26	15.22	15.12	15.02	14.93:
D153	222P	1.5″	20/04/88	16.53	16.15	15.94	15.80	15.67	15.59	15.56	15.52	15.47	15.43:
D153	159P	2.1″	10/04/89	16.77	16.29	16.01	15.84	15.67	15.56	15.54	15.49	15.42	15.37
D153	318P	1.8″	11/04/89	16.61	16.17	15.95	15.79	15.66	15.56	15.55	15.49	15.44	15.39:
D154	159P	2.1″	10/04/89	17.90	17.29	16.93	16.70	16.45	16.28	16.23	16.11:		
D154	165P	2.2″	10/04/89	17.84	17.28	16.93	16.71	16.46	16.28	16.24	16.12	16.00	15.91:
D154	301P	1.6″	11/04/89	17.61	17.12	16.82	16.63	16.42	16.25	16.21	16.11	16.00	15.92:
D154	318P	1.8″	11/04/89	17.64	17.16	16.87	16.65	16.43	16.27	16.22	16.11	15.99:	
D154	321P	2.3″	11/04/89	17.75	17.23	16.92	16.68	16.46	16.31	16.26	16.16:	16.05:	
D154	331P	2.3″	11/04/89	17.74	17.21	16.91	16.69	16.46	16.30	16.25	16.13:	16.03:	
D154	440P	2.5″	12/04/89	17.81	17.23	16.92	16.69	16.45	16.29	16.25	16.15:		

Table 4 (cont.) — Uncorrected V-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. 4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″	32.0″
D155	159P	2.1″	10/04/89	16.35	15.82	15.52	15.30	15.07	14.92	14.88	14.78	14.67	14.59
D155	165P	2.2″	10/04/89	16.32	15.83	15.52	15.31	15.08	14.92	14.88	14.79	14.68	14.60
D155	301P	1.6″	11/04/89	16.09	15.70	15.43	15.24	15.04	14.90	14.86	14.76	14.66	14.58
D155	321P	2.3″	11/04/89	16.21	15.77	15.48	15.28	15.06	14.92	14.88	14.79	14.69	14.61
D155	331P	2.3″	11/04/89	16.25	15.78	15.50	15.27	15.04	14.90	14.87	14.77	14.66	14.57
D155	440P	2.5″	12/04/89	16.28	15.80	15.50	15.29	15.07	14.92	14.88	14.79	14.68	14.60
D156	159P	2.1″	10/04/89	17.43	16.89	16.61	16.45	16.29	16.21	16.18	16.14:		
D156	165P	2.2″	10/04/89	17.35	16.89	16.62	16.46	16.30	16.21	16.20	16.16	16.12:	
D156	301P	1.6″	11/04/89	17.17	16.75	16.51	16.39	16.27	16.19	16.18	16.14	16.10:	
D156	321P	2.3″	11/04/89	17.32	16.82	16.58	16.42	16.29	16.21	16.20	16.16	16.13:	
D156	331P	2.3″	11/04/89	17.26	16.82	16.59	16.43	16.29	16.22	16.20	16.16	16.13:	
D157	113P	2.4″	23/03/87	16.87	16.39	16.16	15.99	15.84	15.72	15.70	15.63	15.52	15.41
D157	159P	2.1″	10/04/89	16.91	16.45	16.18	16.02	15.85	15.73	15.71	15.65	15.57:	
D157	165P	2.2″	10/04/89	16.96	16.43	16.18	16.00	15.84	15.72	15.70	15.64	15.57	15.51:
D157	301P	1.6″	11/04/89	16.70	16.30	16.09	15.97	15.84	15.74	15.72	15.67	15.61	15.59:
D157	305P	1.4″	11/04/89	16.72	16.30	16.08	15.96	15.81	15.72	15.69	15.63	15.55	15.45:
D157	321P	2.3″	11/04/89	16.81	16.37	16.13	15.98	15.83	15.72	15.70	15.64	15.56:	15.50:
D157	331P	2.3″	11/04/89	16.80	16.39	16.15	16.01	15.86	15.75	15.73	15.68	15.62:	15.59:
D157	440P	2.5″	12/04/89	16.87	16.38	16.14	15.99	15.83	15.72	15.70	15.63	15.54:	
D160	305P	1.4″	11/04/89	16.18	15.79	15.55	15.35	15.17	15.05	15.01	14.92	14.80	14.71
D163	204P	1.4″	20/04/88	17.05	16.51	16.13	15.93	15.69	15.51	15.46	15.34	15.20	15.05
D164	204P	1.4″	20/04/88	15.03	14.64	14.37	14.24	14.08	13.95	13.92	13.83	13.73	13.62
D167	149P	1.6″	20/04/88	15.69	15.27	14.99	14.83	14.65	14.51	14.48	14.39	14.27	14.16
D168	303P	1.4″:	11/04/89	15.67	15.23	14.97	14.81	14.65	14.54	14.51	14.45	14.37	14.29
D170	219P	1.4″	20/04/88	16.36	15.99	15.74	15.57	15.39	15.24	15.21	15.11	15.00	14.89
D170	164P	2.2″	10/04/89	16.57	16.06	15.76	15.57	15.35	15.21	15.17	15.07	14.96	14.85
D170	317P	2.3″	11/04/89	16.45	16.00	15.73	15.54	15.34	15.21	15.17	15.07	14.96	14.85

Table 4 (cont.) — Uncorrected V-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. 4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″	32.0″
D171	219P	1.4″	20/04/88	16.69	16.34	16.15	16.04	15.93	15.84	15.81	15.75	15.68:	
D171	164P	2.2″	10/04/89	16.86	16.40	16.19	16.04	15.91	15.82	15.80	15.74	15.68	15.63:
D171	317P	2.3″	11/04/89	16.71	16.33	16.14	16.01	15.88	15.79	15.77	15.71	15.64:	
D172	219P	1.4″	20/04/88	16.12	15.82	15.60	15.47	15.34	15.25	15.23	15.18	15.13	15.09:
D172	164P	2.2″	10/04/89	16.25	15.85	15.63	15.46	15.32	15.23	15.20	15.15	15.10	15.07
D172	317P	2.3″	11/04/89	16.19	15.82	15.58	15.45	15.31	15.22	15.20	15.15	15.10	15.07:
D173	219P	1.4″	20/04/88	16.42	16.08	15.90	15.79	15.67	15.57	15.55	15.49	15.42	15.35:
D173	164P	2.2″	10/04/89	16.57	16.15	15.93	15.79	15.65	15.56	15.53	15.48	15.43	15.39:
D173	317P	2.3″	11/04/89	16.50	16.08	15.87	15.76	15.63	15.54	15.52	15.47	15.41:	15.37:
D174	219P	1.4″	20/04/88	15.96	15.61	15.42	15.29	15.19	15.13	15.12	15.08	15.05	15.03:
D174	317P	2.3″	11/04/89	16.00	15.61	15.40	15.26	15.15	15.09	15.07	15.04	15.02	15.01:
D175	163P	2.0″	10/04/89	16.18	15.71	15.41	15.21	15.00	14.87	14.84	14.75	14.64	14.57
D175	310P	1.7″	11/04/89	16.15	15.65	15.39	15.18	14.99	14.86	14.83	14.74	14.64	14.56
D175	319P	1.9″	11/04/89	16.09	15.63	15.37	15.18	14.99	14.86	14.83	14.74	14.64	14.56
D184	201P	1.4″	20/04/88	18.12	17.52	17.11	16.90	16.66	16.49	16.45	16.33:	16.21:	
D191	303P	1.4″:	11/04/89	16.74	16.42	16.18	16.05	15.91	15.83	15.81	15.77	15.72	15.67:
D193	314P	2.0″	11/04/89	16.65	16.29	16.05	15.90	15.75	15.66	15.64	15.58	15.51	15.45:
D193	437P	2.6″	12/04/89	16.95	16.42	16.14	15.95	15.78	15.68	15.65	15.58	15.51:	15.45:
D194	150P	1.6″	20/04/88	15.51	15.06	14.79	14.61	14.42	14.28	14.24	14.15	14.02	13.90
D194	306P	1.7″	11/04/89	15.51	15.03	14.75	14.59	14.40	14.27	14.23	14.14	14.03	13.92
D194	434P	2.3″:	12/04/89	15.86	15.27	14.93	14.67	14.44	14.30	14.26	14.16	14.03	13.91
D195	306P	1.7″	11/04/89	17.25	16.63	16.18	15.88	15.64	15.50	15.47	15.40	15.33	15.26:
D195	434P	2.3″:	12/04/89	17.59	16.81	16.32	16.02	15.71	15.54	15.50	15.41	15.32	15.23:
D196	150P	1.6″	20/04/88	16.65	16.28	16.10	15.97	15.84	15.74	15.72	15.65	15.56	15.48:
D196	306P	1.7″	11/04/89	16.57	16.23	16.06	15.95	15.83	15.75	15.73	15.68	15.63	15.61
D196	434P	2.3″:	12/04/89	17.03	16.49	16.22	16.04	15.87	15.77	15.74	15.68	15.60	15.55:
D206	154P	1.8″	20/04/88	15.71	15.13	14.74	14.54	14.33	14.18	14.14	14.03	13.91	13.79
D206	313P	1.9″	11/04/89	15.65	15.04	14.68	14.47	14.26	14.11	14.07	13.97	13.86	
D207	154P	1.8″	20/04/88	16.64	16.15	15.84	15.69	15.53	15.42	15.40	15.33	15.25	15.16:
D207	176P	2.8″	20/04/88	16.73	16.16	15.82	15.66	15.50	15.39	15.37	15.30	15.23	15.15
D207	313P	1.9″	11/04/89	16.48	16.03	15.79	15.64	15.48	15.38	15.35	15.29	15.22	15.14:

Table 4 (cont.) — Uncorrected V-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. 4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″	32.0″
D217	122P	2.1″	23/03/87	15.72	15.28	15.03	14.81	14.61	14.47	14.43	14.32	14.19	14.06
D217	151P	1.6″	20/04/88	15.74	15.29	15.04	14.84	14.64	14.49	14.45	14.34	14.20	14.06
D217	202P	1.5″	20/04/88	15.74	15.30	15.00	14.83	14.64	14.49	14.44	14.33	14.20	14.06
D217	207P	1.6″	20/04/88	15.75	15.30	14.99	14.83	14.63	14.48	14.44	14.33	14.20	14.05
D217	214P	1.3″	20/04/88	15.65	15.25	15.00	14.82	14.62	14.48	14.44	14.33	14.19	14.05
D217	220P	1.3″	20/04/88	15.68	15.27	15.00	14.83	14.63	14.48	14.43	14.33	14.19	14.05
D217	166P	2.2″	10/04/89	15.93	15.38	15.06	14.87	14.64	14.49	14.44	14.33	14.20	14.06
D217	312P	1.8″:	11/04/89	15.66	15.27	14.99	14.81	14.62	14.47	14.43	14.33	14.19	14.05
D239	160P	2.5″	10/04/89	15.82	15.34	15.03	14.82	14.58	14.42	14.38	14.26	14.10	13.92
D239	311P	1.8″	11/04/89	15.69	15.26	14.98	14.79	14.57	14.41	14.37	14.25	14.10	13.92
D240	160P	2.5″	10/04/89	15.56	14.95	14.60	14.37	14.12	13.94	13.88	13.76	13.60	13.43
D240	311P	1.8″	11/04/89	15.35	14.88	14.54	14.33	14.10	13.93	13.88	13.76	13.60	13.43
D245	203P	1.4″	20/04/88	16.49	16.07	15.78	15.63	15.46	15.35	15.31	15.24	15.15	15.06

Table 5 — Uncorrected U-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia. 4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″
D68	268	1.9″	11/04/89	17.99	17.50	17.20	17.03	16.85	16.73	16.69	16.58	16.47
D69	268	1.9″	11/04/89	17.47	17.01	16.76	16.59	16.40	16.29	16.25	16.17	16.07
D70	268	1.9″	11/04/89	17.77	17.34	17.09	16.94	16.76	16.65	16.62	16.54	16.44
D71	268	1.9″	11/04/89	18.93	18.37	18.02	17.82	17.61	17.46:	17.42:	17.36:	
D87	427	2.5″	12/04/89	18.57	18.03	17.76	17.59	17.42	17.32:	17.29:	17.25:	
D103	285	1.7″	21/04/88	17.17	16.77	16.56	16.45	16.33	16.24	16.22	16.16	16.08:
D104	127	2.2″	23/03/87	17.65	17.21	16.98	16.82	16.69	16.60	16.57	16.52	16.44
D104	285	1.7″	21/04/88	17.60	17.14	16.92	16.79	16.66	16.57	16.54	16.49	16.40:
D106	285	1.7″	21/04/88	17.90	17.55	17.34	17.21	17.09	17.05	17.02	16.99	16.97
D107	285	1.7″	21/04/88	18.33	17.86	17.53	17.33	17.12	17.01:	16.97:		
D116	429	2.6″	12/04/89	18.29	17.64	17.26	17.10	16.90	16.76	16.73:	16.63:	
D117	270	1.8″	11/04/89	18.40	17.95	17.65	17.47	17.31	17.22	17.20	17.10:	17.00:
D118	270	1.8″	11/04/89	17.69	17.16	16.88	16.66	16.45	16.29	16.25	16.15	16.01
D119	429	2.6″	12/04/89	18.21	17.76	17.47	17.30	17.12	16.99:	16.95:		
D120	286	1.7″	11/04/89	17.04	16.57	16.31	16.10	15.86	15.65	15.59	15.46	15.34
D122	274	1.9″	21/04/88	17.83	17.42	17.17	17.01	16.84	16.71	16.68	16.59	16.49:
D122	286	1.7″	11/04/89	17.88	17.42	17.19	17.01	16.83	16.72	16.68	16.63	16.55
D124	127	2.2″	23/03/87	17.50	17.06	16.82	16.62	16.47	16.36	16.33	16.26	16.20
D125	127	2.2″	23/03/87	17.92	17.53	17.34	17.22	17.11	17.05	17.04	17.01	16.95
D126	115	1.8″	23/03/87	18.49	18.02	17.75	17.55	17.35	17.23:	17.20:	17.14:	
D126	267	1.9″	11/04/89	18.74	18.09	17.70	17.49	17.32	17.18:	17.14:		
D126	288	1.8″	11/04/89	18.45	17.92	17.67	17.46	17.29:				
D126	441	3.0″	12/04/89	18.96	18.28	17.88	17.63:	17.34:				
D127	115	1.8″	23/03/87	18.85	18.40	18.13	17.97	17.81	17.73:	17.70:		
D127	267	1.9″	11/04/89	19.02	18.43	18.16	17.94	17.74:				
D127	288	1.8″	11/04/89	18.74	18.32	18.11	17.93:					
D127	430	2.5″	12/04/89	18.96	18.44	18.17	17.99:					
D128	115	1.8″	23/03/87	18.26	17.87	17.63	17.49	17.33	17.22	17.19	17.16:	
D128	267	1.9″	11/04/89	18.27	17.88	17.64	17.50	17.37	17.29:	17.30:		
D128	288	1.8″	11/04/89	18.24	17.90	17.66	17.54	17.44:	17.36:			
D128	441	3.0″	12/04/89	18.68	18.12	17.79	17.62:	17.44:				

Table 5 (cont.) — Uncorrected U-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia.								
				4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″
D129	115	1.8″	23/03/87	17.67	16.97	16.54	16.17	15.83	15.58	15.52	15.34	15.11
D129	267	1.9″	11/04/89	17.61	16.91	16.48	16.16	15.82	15.58	15.51	15.34	15.12
D129	288	1.8″	11/04/89	17.60	16.89	16.46	16.15	15.81	15.57	15.51	15.34	15.11
D129	441	3.0″	12/04/89	17.90	17.09	16.54	16.21	15.87	15.61	15.53	15.34	15.13
D130	115	1.8″	23/03/87	17.38	16.93	16.71	16.55	16.41	16.31	16.28	16.22	16.13
D130	267	1.9″	11/04/89	17.38	16.94	16.72	16.58	16.45	16.37	16.36	16.31	16.26:
D130	288	1.8″	11/04/89	17.40	16.96	16.67	16.54	16.42	16.32	16.30	16.26	16.19:
D130	441	3.0″	12/04/89	17.60	17.06	16.77	16.58	16.42	16.30	16.28	16.20:	16.15:
D131	115	1.8″	23/03/87	17.63	17.19	16.94	16.76	16.58	16.44	16.39	16.30	16.17
D131	267	1.9″	11/04/89	17.66	17.17	16.89	16.73	16.53	16.40	16.36	16.26	16.15:
D131	288	1.8″	11/04/89	17.60	17.16	16.90	16.74	16.56	16.41	16.38	16.28	16.18:
D131	441	3.0″	12/04/89	17.96	17.34	16.97	16.77	16.56	16.41	16.36	16.26:	16.15:
D132	115	1.8″	23/03/87	18.49	18.06	17.81	17.65	17.47	17.33:	17.29:		
D132	267	1.9″	11/04/89	18.72	18.10	17.79	17.60	17.45:				
D132	284	1.6″	11/04/89	18.41	18.00	17.76	17.59	17.40	17.26:	17.22:	17.13:	
D132	288	1.8″	11/04/89	18.49	18.06	17.81	17.65	17.45:				
D132	441	3.0″	12/04/89	18.94	18.30	17.94	17.81:					
D133	284	1.6″	11/04/89	17.33	16.90	16.62	16.48	16.33	16.22	16.20	16.12	16.05
D134	428	2.3″	12/04/89	18.72	18.22	17.99	17.87	17.74:				
D135	428	2.3″	12/04/89	18.72	18.25	17.92	17.74	17.58	17.47:	17.44:		
D136	428	2.3″	12/04/89	18.04	17.57	17.33	17.22	17.11	17.03	17.01	16.96:	
D143	284	1.9″	21/04/88	17.79	17.20	16.83	16.57	16.28	16.07	16.00	15.85	15.66
D144	429	2.6″	12/04/89	17.59	17.04	16.75	16.58	16.39	16.27	16.24	16.14	16.01:
D145	284	1.9″	21/04/88	18.04	17.56	17.30	17.11	16.92	16.78:	16.74:		
D147	429	2.6″	12/04/89	18.62	18.01	17.66	17.45	17.24	17.08:	17.03:		
D148	274	1.9″	21/04/88	16.90	16.23	15.81	15.53	15.23	15.01	14.95	14.79	14.58
D148	286	1.7″	11/04/89	16.82	16.18	15.80	15.51	15.24	15.02	14.95	14.79	14.59
D150	274	1.9″	21/04/88	18.04	17.59	17.32	17.13	16.93	16.81	16.78	16.72	16.64:

Table 5 (cont.) — Uncorrected U-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia.								
				4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″
D151	274	1.9″	21/04/88	17.50	17.05	16.73	16.52	16.30	16.12	16.08	15.96	15.82
D151	286	1.7″	11/04/89	17.50	17.02	16.74	16.54	16.33	16.17	16.12	16.02	15.88
D152	115	1.8″	23/03/87	18.09	17.64	17.35	17.15	16.94	16.81	16.78	16.71:	16.64:
D152	267	1.9″	11/04/89	18.01	17.54	17.29	17.09	16.88	16.73	16.71	16.64:	
D152	288	1.8″	11/04/89	18.01	17.55	17.24	17.05	16.87	16.73:	16.69:	16.60:	
D152	430	2.5″	12/04/89	18.16	17.58	17.25	17.04	16.84	16.69	16.66:	16.57:	
D152	441	3.0″	12/04/89	18.24	17.68	17.36	17.14	16.92	16.77:	16.72:		
D153	430	2.5″	12/04/89	18.31	17.75	17.47	17.27	17.08	16.93:	16.90:		
D154	267	1.9″	11/04/89	19.00	18.55	18.26	18.05	17.84:				
D154	288	1.8″	11/04/89	19.11	18.57	18.30	18.07:	17.87:				
D154	430	2.5″	12/04/89	19.20	18.60	18.27	18.02:	17.77:				
D155	267	1.9″	11/04/89	17.63	17.18	16.91	16.69	16.48	16.33	16.30	16.20	16.08:
D155	288	1.8″	11/04/89	17.66	17.19	16.90	16.72	16.50	16.36	16.31	16.22	16.15:
D155	430	2.5″	12/04/89	17.87	17.27	16.93	16.71	16.46	16.30	16.25	16.15	16.03:
D155	441	3.0″	12/04/89	17.91	17.34	16.96	16.73	16.47	16.30	16.26	16.14:	16.01:
D156	288	1.8″	11/04/89	18.64	18.15	17.93	17.83	17.69:				
D156	430	2.5″	12/04/89	18.83	18.22	17.88	17.65	17.47:				
D156	441	3.0″	12/04/89	18.95	18.32	17.92	17.74:					
D157	115	1.8″	23/03/87	18.33	17.85	17.53	17.39	17.23	17.13	17.11	17.03:	
D157	267	1.9″	11/04/89	18.46	17.81	17.54	17.37	17.21	17.10:	17.07:		
D157	284	1.6″	11/04/89	18.14	17.70	17.47	17.33	17.18	17.11	17.09	17.00:	16.90:
D157	288	1.8″	11/04/89	18.10	17.73	17.52	17.36	17.24:	17.16:	17.15:		
D157	441	3.0″	12/04/89	18.45	17.88	17.60	17.40	17.22:				
D158	284	1.6″	11/04/89	18.89	18.42	18.16	18.00	17.86:	17.74:	17.72:		
D160	284	1.6″	11/04/89	17.82	17.32	17.04	16.86	16.66	16.53	16.50	16.40:	
D167	284	1.9″	21/04/88	17.20	16.75	16.47	16.30	16.10	15.96	15.92	15.83	15.70
D168	269	1.9″:	11/04/89	17.31	16.81	16.54	16.34	16.15	16.04	16.01	15.93	15.84
D170	287	2.0″	21/04/88	17.93	17.44	17.16	16.96	16.76	16.62	16.58	16.49	16.39:

Table 5 (cont.) — Uncorrected U-band Photometry in the Coma Cluster

Galaxy	Frame	Seeing	Date	Aperture Dia.								
				4.0″	6.0″	8.0″	10.0″	13.0″	16.0″	17.0″	20.0″	25.0″
D171	287	2.0″	21/04/88	18.25	17.78	17.56	17.43	17.32	17.24	17.20:	17.12:	
D172	287	2.0″	21/04/88	17.69	17.25	17.01	16.86	16.71	16.61	16.58	16.53	16.49:
D173	287	2.0″	21/04/88	17.97	17.57	17.33	17.19	17.05	16.95	16.91	16.84:	16.76:
D174	287	2.0″	21/04/88	17.58	17.15	16.91	16.76	16.62	16.55	16.54	16.50	16.46:
D175	287	1.6″	11/04/89	17.64	17.17	16.89	16.69	16.49	16.35	16.32	16.23	16.11:
D191	269	1.9″:	11/04/89	18.29	17.84	17.58	17.41	17.27	17.17	17.15	17.08:	
D194	285	1.6″:	11/04/89	17.16	16.67	16.39	16.18	15.98	15.82	15.78	15.68	15.55
D195	285	1.6″:	11/04/89	17.75	17.06	16.56	16.25	16.00	15.87	15.83	15.76	15.68
D196	285	1.6″:	11/04/89	18.23	17.76	17.51	17.38	17.26	17.16	17.13:	17.07:	
D206	155	2.1″	20/04/88	17.20	16.56	16.20	16.00	15.76	15.60	15.56	15.44	15.30
D207	155	2.1″	20/04/88	18.08	17.56	17.28	17.09	16.93	16.83	16.81	16.75:	
D217	124	2.0″	23/03/87	17.43	16.91	16.56	16.38	16.17	16.01	15.97	15.85	15.72
D217	286	1.9″	21/04/88	17.29	16.81	16.54	16.34	16.14	15.98	15.94	15.83	15.68

Table 6a — Seeing Corrections (magnitudes) for Virgo ($r_e = 30''$)

PSF ("FWHM)	Aperture Dia. 4.0"	6.0"	8.0"	10.0"	13.0"	16.0"	20.0"	25.0"	32.0"	40.0"	50.0"	60.0"
3.70	0.52	0.31	0.20	0.14	0.09	0.06	0.04	0.02	0.01	0.01	0.01	0.00
3.60	0.50	0.30	0.19	0.13	0.08	0.06	0.04	0.02	0.01	0.01	0.00	0.00
3.50	0.48	0.28	0.18	0.12	0.08	0.05	0.03	0.02	0.01	0.01	0.00	0.00
3.40	0.46	0.27	0.17	0.12	0.07	0.05	0.03	0.02	0.01	0.01	0.00	0.00
3.30	0.45	0.26	0.16	0.11	0.07	0.05	0.03	0.02	0.01	0.01	0.00	0.00
3.20	0.43	0.25	0.15	0.11	0.07	0.05	0.03	0.02	0.01	0.01	0.00	0.00
3.10	0.41	0.23	0.15	0.10	0.06	0.04	0.03	0.02	0.01	0.01	0.00	0.00
3.00	0.39	0.22	0.14	0.10	0.06	0.04	0.03	0.02	0.01	0.01	0.00	0.00
2.90	0.37	0.21	0.13	0.09	0.06	0.04	0.02	0.02	0.01	0.01	0.00	0.00
2.80	0.36	0.20	0.12	0.08	0.05	0.04	0.02	0.02	0.01	0.01	0.00	0.00
2.70	0.33	0.18	0.11	0.08	0.05	0.03	0.02	0.01	0.01	0.00	0.00	0.00
2.60	0.32	0.18	0.11	0.08	0.05	0.03	0.02	0.01	0.01	0.00	0.00	0.00
2.50	0.30	0.16	0.10	0.07	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00
2.40	0.28	0.15	0.09	0.06	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00
2.30	0.26	0.14	0.09	0.06	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00
2.20	0.24	0.13	0.08	0.06	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.00
2.10	0.23	0.12	0.08	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00
2.00	0.21	0.11	0.07	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00
1.90	0.19	0.10	0.07	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00
1.80	0.18	0.10	0.06	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00
1.70	0.17	0.09	0.05	0.04	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00
1.60	0.15	0.08	0.05	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00
1.50	0.14	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
1.40	0.13	0.06	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
1.30	0.12	0.06	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
1.20	0.11	0.06	0.04	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
1.10	0.09	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
1.00	0.08	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
0.90	0.07	0.04	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
0.80	0.06	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
0.70	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Table 6b — Seeing Corrections (magnitudes) for Coma ($r_e = 5''$)

PSF	Aperture Dia.									
("FWHM)	4.0"	6.0"	8.0"	10.0"	13.0"	16.0"	17.0"	20.0"	25.0"	32.0"
3.70	0.70	0.39	0.23	0.15	0.09	0.06	0.05	0.03	0.02	0.01
3.60	0.67	0.37	0.22	0.14	0.08	0.05	0.05	0.03	0.02	0.01
3.50	0.64	0.35	0.21	0.13	0.08	0.05	0.04	0.03	0.02	0.01
3.40	0.61	0.33	0.20	0.13	0.07	0.05	0.04	0.03	0.02	0.01
3.30	0.59	0.32	0.19	0.12	0.07	0.05	0.04	0.03	0.02	0.01
3.20	0.56	0.30	0.18	0.11	0.07	0.04	0.04	0.03	0.01	0.01
3.10	0.54	0.29	0.17	0.11	0.06	0.04	0.04	0.02	0.01	0.01
3.00	0.51	0.27	0.16	0.10	0.06	0.04	0.03	0.02	0.01	0.01
2.90	0.48	0.25	0.14	0.09	0.06	0.04	0.03	0.02	0.01	0.01
2.80	0.46	0.24	0.14	0.09	0.05	0.03	0.03	0.02	0.01	0.01
2.70	0.43	0.22	0.13	0.08	0.05	0.03	0.03	0.02	0.01	0.01
2.60	0.41	0.21	0.12	0.08	0.05	0.03	0.03	0.02	0.01	0.01
2.50	0.38	0.19	0.11	0.07	0.04	0.03	0.02	0.02	0.01	0.00
2.40	0.36	0.18	0.10	0.07	0.04	0.03	0.02	0.02	0.01	0.00
2.30	0.33	0.17	0.10	0.06	0.04	0.02	0.02	0.02	0.01	0.00
2.20	0.30	0.15	0.09	0.06	0.03	0.02	0.02	0.01	0.01	0.00
2.10	0.28	0.14	0.08	0.05	0.03	0.02	0.02	0.01	0.01	0.00
2.00	0.26	0.13	0.08	0.05	0.03	0.02	0.02	0.01	0.01	0.00
1.90	0.24	0.12	0.07	0.05	0.03	0.02	0.02	0.01	0.01	0.00
1.80	0.22	0.11	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.00
1.70	0.20	0.10	0.06	0.04	0.02	0.02	0.01	0.01	0.01	0.00
1.60	0.18	0.09	0.05	0.04	0.02	0.01	0.01	0.01	0.01	0.00
1.50	0.16	0.08	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00
1.40	0.15	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00
1.30	0.13	0.06	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00
1.20	0.12	0.06	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00
1.10	0.11	0.06	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00
1.00	0.10	0.05	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00
0.90	0.08	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00
0.80	0.07	0.04	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00
0.70	0.06	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00

Table 8

Raw J- and K-Band Photometry in the Coma Cluster

Galaxy I.D.	Date	Chop Dir.	J	K
D10	11/3/87	NS	13.52	12.62
D31	7/3/87	NS	11.54	10.58
	7/3/87	NS	11.57	
	9/3/87	NS	11.52	10.55
D49	8/3/87	EW	11.56	10.57
D67	10/3/87	EW	13.25	12.32
D69	7/3/87	NS	12.32	11.36
	9/3/87	NS	12.32	11.35
D70	8/3/87	EW	12.95	12.01
	10/3/87	EW	12.93	11.98
D78	8/3/87	EW	12.09	11.15
	9/3/87	NS	12.13	11.16
D79	10/3/87	EW	12.12	11.17
	11/3/87	NS	12.12	11.15
D81	10/3/87	EW	13.43	12.53
D84	10/3/87	EW	13.09	12.13
D87	7/3/87	NS	13.95	13.04
	8/3/87	EW	13.94	13.00
	9/3/87	NS	13.94	13.01
D91	10/3/87	EW	12.26	11.31
D95	10/3/87	EW	12.53	11.55
D96	10/3/87	EW	12.82	11.83
D97	10/3/87	EW	11.99	11.03
D107	7/3/87	NS	13.60	12.68
	9/3/87	NS	13.60	12.68
D110	10/3/87	NS	13.51	12.58
D118	8/3/87	EW	12.48	11.54
D121	8/3/87	EW	11.84:	10.84:
	10/3/87	EW	11.83:	10.81:
D124	8/3/87	EW	12.53	11.58
D125	7/3/87	NS	13.51	12.59
	8/3/87	EW	13.46	12.53
	9/3/87	NS	13.50	12.60
D126	8/3/87	EW	14.05	13.21
D127	9/3/87	NS	13.80	12.86
D128	8/3/87	EW	13.58	12.65
	11/3/87	NS	13.58	12.60
D129	8/3/87	EW	11.56	10.56
	10/3/87	EW	11.59	10.58
D130	7/3/87	NS	12.42	11.44
	9/3/87	NS	12.45	11.48
D133	7/3/87	NS	12.46	11.50
	9/3/87	NS	12.43	11.46

Table 8 (cont.)

Galaxy I.D.	Date	Chop Dir.	J	K
D136	7/3/87	NS	13.41	12.48
	7/3/87	NS	13.41	12.48
	8/3/87	EW	13.43	12.48
D143	7/3/87	NS	12.08	11.12
D144	8/3/87	EW	12.38	11.41
D148	8/3/87	EW	10.84	9.85
	10/3/87	EW	10.84	9.85
D150	8/3/87	EW	13.17	12.22
	10/3/87	EW	13.14	12.23
D151	7/3/87	NS	12.47	11.55
D152	9/3/87	NS	12.85	11.88
D153	8/3/87	EW	13.24	12.29
	9/3/87	NS	13.26	12.30
D154	9/3/87	NS	14.05	13.21
D159	7/3/87	NS	star superposed	
D164	10/3/87	EW	11.67	10.74
D165	11/3/87	NS	13.40	12.46
D168	8/3/87	EW	12.13	11.13
	9/3/87	NS	12.11	11.13
D170	9/3/87	NS	13.07	12.05
D172	7/3/87	NS	12.94	11.94
	9/3/87	NS	12.90	11.89
D174	7/3/87	NS	12.71	11.72
	8/3/87	EW	12.71	11.71
D175	8/3/87	EW	12.45	11.47
	9/3/87	NS	12.47	11.50
D184	10/3/87	EW	14.21	13.33
D193	8/3/87	EW	13.33	12.42
	9/3/87	NS	13.38	12.44
D194	7/3/87	NS	11.82	10.83
	9/3/87	NS	11.79	10.80
D207	7/3/87	NS	13.03	12.10
	9/3/87	NS	13.08	12.11
D217	8/3/87	EW	12.07	11.12
D225	10/3/87	NS	14.28	13.38
D240	7/3/87	NS	11.51	10.55
	8/3/87	NS	11.52	10.56
D242	10/3/87	EW	13.27	12.31
D245	10/3/87	EW	13.09	12.14
RB74	10/3/87	EW	14.09	13.28

Notes:

1. Where possible, galaxies have been identified following Dressler's (1980) list of morphological types. RB74 is identified in Rood & Baum, 1967.
2. All measurements have been corrected to a 17″ top-hat aperture. No correction has been applied for the intra-cluster light.
3. The measurements of galaxy D121 are contaminated by light from D120.

Table 9

Corrections for Intra-Cluster Light

Galaxy	Chop Dir.	ΔV
D124	EW	0.00
D125	EW	0.02
	NS	−0.07
D126	EW	−0.25:
D127	NS	0.20
D128	EW	0.16
	NS	0.18
D129	EW	−0.01
D130	NS	0.10
D148	EW	0.00
D150	EW	0.02
D151	NS	0.07
D152	NS	0.00
D153	EW	0.00
	NS	−0.02
D154	NS	−0.05:

Note: the correction ΔV is to be added to the magnitude measured by UKIRT to correct to local sky magnitude.